# Battery Park City

## 2023 Urban Tree Canopy & Biodiversity Data Audit and Recommendations

Executive Summary



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# Introduction

This Executive Summary was developed as part of the Battery Park City Sustainability Services tasks and summarizes the work of the 2023 Urban Tree Canopy Assessment and Recommendations and the 2023 Biodiversity Data Audit and Recommendations.

The analysis and recommendations contained herein were developed by SCAPE Landscape Architecture and AKRF with guidance from Buro Happold (the prime consultant).

# Project Background

In 2020, The Battery Park City Authority (BPCA) released its comprehensive 10-year **Battery Park City Sustainability Plan** which puts forth a holistic vision for environmental sustainability, including health and wellness, environmental quality, and education, and is organized into four topic areas: Energy, Water, Materials and Waste, and Site. The work described here was conducted to support two goals in particular:

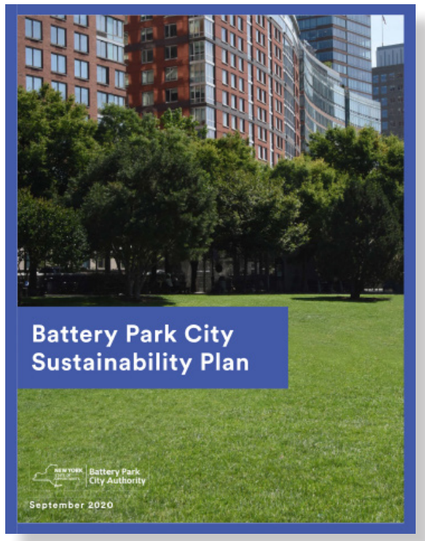
The **Biodiversity and Habitats** goal aims to "enhance the biodiversity of plant and animal life at Battery Park City and ensure that the wildlife is resilient to the changing climate." Specifically, action [S-1.3a] Expand and Enhance Existing Habitats calls on BPCA to "conduct a simplified audit of biodiversity to calculate a biodiversity index."

The **Quality of Life** goal aims to "[i]mprove the environmental quality and pedestrian environment of Battery Park City by addressing air quality, noise pollution, and the urban heat island effect." Specifically, action [S-2.1a] Mitigate the Urban Heat Island (UHI) Effect calls on BPCA to "measure and assess the BPC tree canopy."

To advance these actions as well as support the maintenance and operations needs of BPCA horticultural staff, BPCA retained a team of consultants to undertake:

- Urban Tree Canopy (UTC) Assessment and Recommendations; and
- Biodiversity Data Audit and Recommendations (including a Plant Species Inventory).

The purpose, process, and results of this work are described in this executive summary report.




### Quality of Life Goal

**"Improve the environmental quality and pedestrian environment of Battery Park City by addressing air quality, noise pollution, and the urban heat island effects."**

### Biodiversity and Habitats Goal

**"Enhance the biodiversity of plant and animal life at Battery Park City and ensure that the flora and fauna is resilient to the changing climate."**



# Project Goals & Outcomes

The goals of the Urban Tree Canopy Assessment were to:

- Recommend a software tool to collect baseline tree data and to track and manage trees over time.
- Develop protocols for the baseline and future tree inventories and assessments.
- Conduct a baseline tree inventory to document the baseline condition (e.g., species, size, health, etc.) of Battery Park City's trees.
- Based on the baseline tree inventory, assess the health and structure of individual trees and analyze the status of Battery Park City's trees/tree canopy with respect to biodiversity, resiliency, habitat/wildlife support, and management.
- Identify measures to improve the health of existing trees and provide recommendations with respect to tree management, tree replacements, and new tree plantings in response to existing and anticipated future conditions.
- Provide recommendations on ways to enhance/improve the biodiversity, resiliency, and habitat function/wildlife value of Battery Park City's tree canopy.

The goals of the biodiversity data audit and recommendations were to:

- Review BPCA's current biodiversity data collection methodologies and provide recommendations on ways to formalize and improve such methods.
- Conduct a precedent study on biodiversity tracking and data collection methods of other park systems, organizations, and campuses.
- Develop protocols for the baseline and future inventory of plants in Battery Park City's planted areas.
- Conduct a baseline inventory of all plant species within Battery Park City.
- Based on the baseline plant species inventory, assess species presence and abundance to understand the composition of BPC's planted areas and assess key characteristics of the observed vegetation as they relate to ecological performance, habitat/wildlife value, and tolerance to environmental stressors.
- Provide recommendations on ways to enhance local biodiversity and resilience as well as contribute to the larger urban ecosystem.

# Project Process

To advance those goals the project included the following work.

### DATA AUDIT AND PRECEDENT STUDY

This included an audit of BPCA's existing biodiversity data and data collection methodologies based on workshops and interviews with BPCA Horticulture and Parks Programming staff and precedent studies of biodiversity tracking practices and tree management software used by similar organizations.

### METHODOLOGY AND SOFTWARE CUSTOMIZATION

Protocols for the performance of both a Tree Inventory and a Plant Species Inventory were developed in parallel with the review and selection of a software platform for data collection and management. A database of species-dependent information related to key biodiversity, habitat value, and resiliency characteristics of plants in Battery Park City (the plant species characteristics database) was also prepared during this phase. BPCA's project team then coordinated with the selected software provider, TreePlotter, to customize its interface for Battery Park City.

### DATA COLLECTION (FIELDWORK)

The Battery Park City-wide Tree and Plant Species Inventories took place concurrently from June through August 2023. An additional inventory of spring ephemeral plants was performed in April 2023.

### ENGAGEMENT

BPCA held two community engagement events in September 2023 to raise awareness about the work and answer related questions. These events included tabling at the Migration Celebration and a Tuesday Talk during Climate Week.

### ANALYSIS AND REPORTING

The data collected from the Tree and Plant Species Inventories was reviewed and analyzed. Based on the findings, recommendations were made for future planning, design, and management, as well as areas for further study. Additionally, an Urban Heat Island (UHI) analysis was conducted using the Tree Inventory data.



*Pilot Workshop*



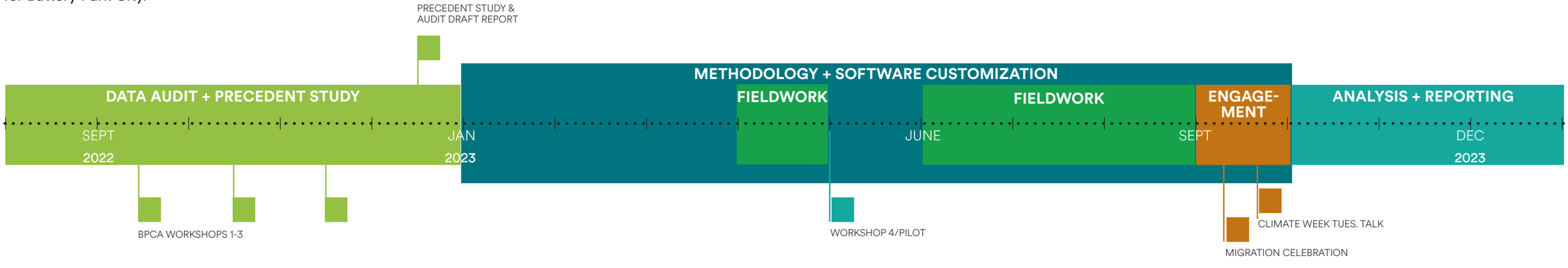
*Migration Celebration*



*Summer Fieldwork*



*Climate Week Tuesday Talk Demonstration*



# Data Digitization

## AUDIT OF CURRENT BPCA PRACTICES

An early phase of the project focused on assessing current BPCA horticultural management and biodiversity monitoring and assessment practices. The project team worked with BPCA staff to understand daily and seasonal horticulture operations, garden and tree maintenance practices, experience with implementing data collection protocols, planning and plant selection practices, current tools used for plant and other species identification, desired outcomes of a biodiversity program, existing institutional partnerships, and public engagement practices.

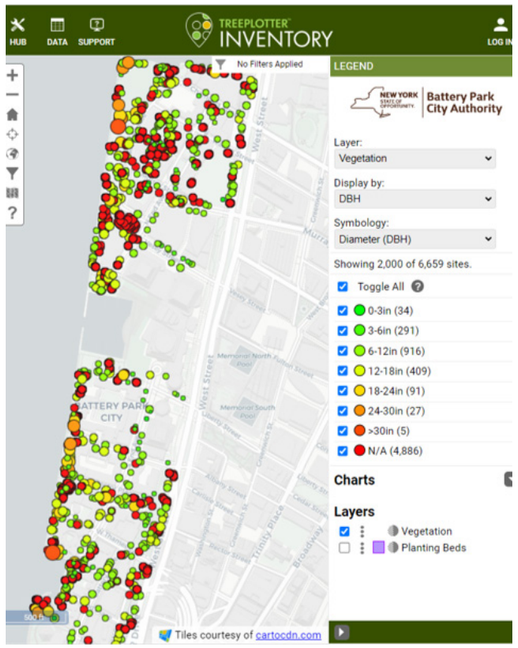
The team assessed existing biodiversity data collection, analysis, and monitoring practices alongside plant species lists, planting plans, garden bed management information, and tree management records to better understand standard BPCA practices and existing conditions. This helped the team understand organizational capacities and standard operations, and informed recommendations on how to formalize and improve such practices.

These recommendations led to the development of the tree and plant inventory protocols, as well as the selection and customization of a software platform to manage, organize, and store BPCA's tree and horticultural information.

## A DIGITAL PLATFORM

BPCA evaluated a number of software platforms for entering and managing data and tracking maintenance over time before selecting TreePlotter as the digital data management platform.  TreePlotter is a web-based platform that organizes and stores large datasets and provides geolocated data entry specifically designed for tree inventories and management. The interface is user-friendly for both desktop reporting and analysis, as well as in-field observations and assessments. The software is designed to conduct tree inventories and was initially selected to support the Urban Tree Canopy Assessment. It has common tools for horticultural and forestry maintenance and future assessments, as well as a public engagement interface.

The platform was customized to BPCA's needs including supporting data management for the Plant Species Inventory and the use of new performance metrics, planting bed areas, and entry of non-tree species (such as shrubs, perennials, vines, etc.) abundance data. This software was used to collect baseline data during the Tree and Plant Species Inventories.




*TreePlotter software interface*

## DIGITIZATION OF BPCA PLANTED AREAS

In order to digitize and modernize BPCA's records of planted areas, the consultant team created a digitized map of all planted areas based on satellite imagery, digital surveys, BPC plan drawings, and on-the-ground observations. The "planted areas" identified included 632 tree pits, 257 park tree pits, 218 planting beds, and 9 lawn areas. These were drawn and uploaded into TreePlotter prior to the plant species inventory. Tree locations were identified in the field using a hand-held GPS during the tree inventory.

## PLANT DATABASE

BPC Sustainability Plan actions [S-1.3] and [S-1.4] provide direction to assess key characteristics of the observed vegetation as they relate to ecological performance, wildlife value, and tolerance to environmental stressors. This includes an assessment of species presence and abundance to better understand the composition of BPC's planted areas.

To meet this goal, the team developed a database of plant species characteristics as well as performance measures to support these assessments. The plant species characteristics database draws from reputable scientific and horticultural industry standard sources and includes data on the following plant characteristics: Native Status, Invasive Status, Hardiness Zone, Light Requirements, Flowering/ Bloom Period, Fruiting Period, Drought Tolerance, Salt Spray Tolerance, Salty Soils Tolerance, Saltwater Intrusion Tolerance, Flood/ Saturation Tolerance, Climate Vulnerability, Wildlife Value, and C-Value  (a metric for tolerance to disturbed sites).




*Project limts. Areas under-construction or not maintained by Battery Park City were excluded.*

# Data Collection: Protocols & Fieldwork

Developing the methods and protocols for the 2023 baseline tree and plant species inventories, including their applicability for future inventories, was a critical part of the project. Two sets of protocols were developed—one for the tree inventory and one for the plant species inventory—which work in a complementary manner such that tree inventory data could be incorporated into the broader plant species inventory. Both inventories drew on available best practices, which were researched during the early phases of the project, but modified and adapted to suit the particular characteristics and needs of Battery Park City and the Battery Park City Authority. A general description of the protocols used for the 2023 Tree Inventory and 2023 Plant Species Inventory are included below. Detailed protocol manuals were prepared to guide the team collecting data in the field and support consistency of future data collection.

## TREE INVENTORY

The tree inventory was conducted using customized protocols developed by the consultant team in coordination and consultation with BPCA. The tree condition scoring protocols were derived largely from the New York City Department of Parks and Recreation (NYC Parks) Tree Valuation Protocol. The NYC Parks Tree Valuation Protocol uses an adapted version of the Council of Tree and Landscape Appraisers (CTLA) tree assessment methods that have been customized to trees of New York City. The protocols related to tree maintenance were customized according to BPCA's maintenance practices and TreePlotter's inspection and maintenance features.
Data collected included tree species; basic information like dimensions and age class; tree condition (health and structure of roots, trunk, branches, foliage, and buds); and various maintenance information.

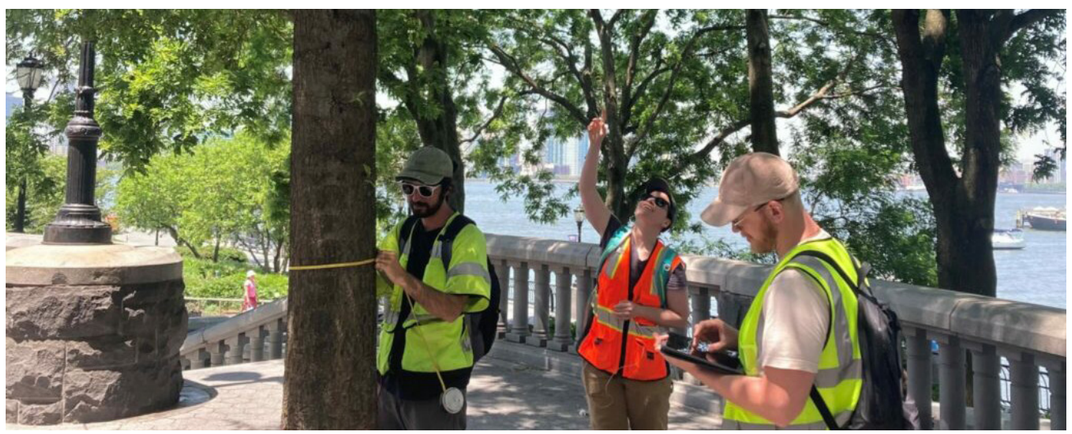
## PLANT SPECIES INVENTORY

The Plant Species Inventory was conducted using a set of protocols customized to Battery Park City's scale and urban context. These protocols were developed to support the 2023 baseline inventory as well as provide an accessible, replicable method to support long-term plant species and biodiversity tracking. Study of other plant monitoring and biodiversity tracking practices revealed a general lack of methodological precedents and tools for comprehensively documenting plants to support biodiversity in the context and scale of an urban district like Battery Park City. Thus, while plant inventory protocols draw from various sources, they are specific to Battery Park City.

Plant inventories in naturalized contexts typically use a standard square survey plot of consistent size for observation, gridded across a large, mostly vegetated survey site with individual survey plots randomly distributed/selected. However, the urban fabric of Battery Park City includes a network of isolated planting beds, lawns, and tree pits separated by significant unvegetated areas including paths, pavement, and buildings. Thus, a customized approach to the survey plot had to be developed in order to provide comprehensive coverage of plant species found in Battery Park City's planted areas.

A standardized "survey group" of approximately 1/8 acre was established and applied where feasible. This often required that larger beds be broken up into multiple survey groups, or that smaller separate beds (for instance tree pits) be grouped together into a single survey group. Ultimately, the team inventoried the plants in 265 survey groups across 13 parks and streetscapes, comprising 10.5 acres of vegetated area within BPC's 36 acres of open space.

Data points were collected for each species found within a survey group and included the coverage of each species in one of the following abundance categories: Rare (1-5%), Sparse (5-25%), Occasional (25-50%), Frequent (50-75%), Very Common (75-90%), Abundant (90-100%). Additional data collected on each planting bed included the percent unvegetated area and information on the vegetation structure and cover for six strata types: Tree Canopy, Tree Subcanopy (e.g. smaller fruit trees, saplings), Mid-Upper Shrub/Sapling , Low Shrub/Sapling, Herbaceous (e.g perennials), and Woody Vines.



*Tree Inventory, June 2023*



*Plant Species Inventory, August 2023*

# Results and Recommendations

The following section includes analyses and recommendations related to the overall biodiversity, habitat value, and resilience of Battery Park City's urban tree canopy and planted areas.

The analyses presented were selected in order to support action items identified in Battery Park City's Sustainability Plan, and in particular those related to Quality of Life and Biodiversity and Habitats.

# Understanding the Results

The analyses performed for this project included the following subject areas:

**Biodiversity**: Including general biodiversity, native species, and invasive species

**Habitat and Wildlife Value:** Including observed wildlife, habitat for birds, bloom period, and habitat for specialist insects

**Resiliency:** Including drought, flooding/ saturation, and salt [spray, inundation, and soils] tolerance

Each of these subject areas includes analysis for BPC as a whole (represented using **donut charts**) and on a park-by-park basis (represented using **bar graphs**). In all cases, the breakdown of plants relevant to each subject area are provided in terms of:

***SPECIES COMPOSITION*** *- a percentage of the total species*

***AREA COVERAGE*** *- a percentage of the total vegetative cover*

native to NE
native to USA
non-native

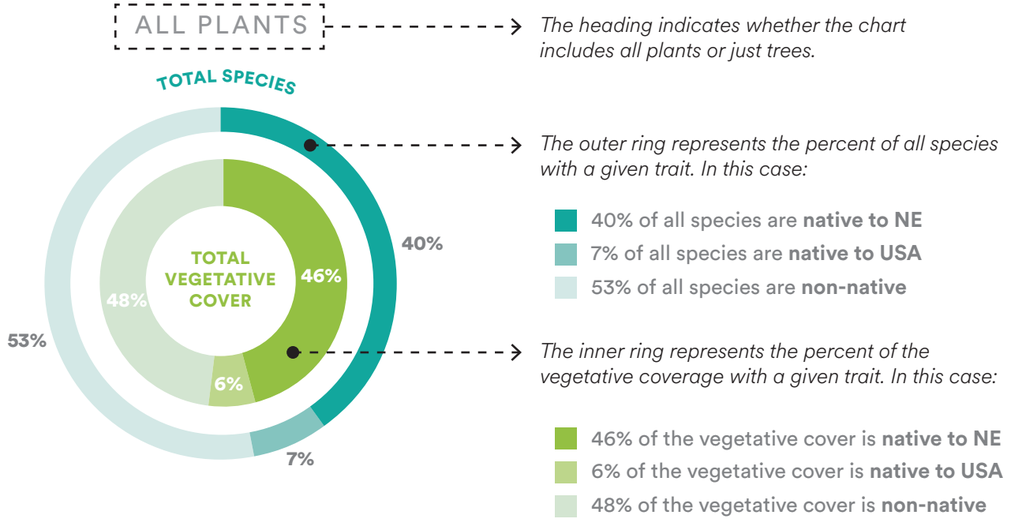
The data about species presence and percent cover used in these analyses were collected at the base unit of the survey group. A survey group is a planted area or collection of planted areas of appropriate size and proximity so that they can be visually assessed in the field in a comprehensive manner. The data for all survey groups within an area were then compiled to understand trends across an entire area or "park". The maps in this report illustrate vegetation patterns at either the level of the park or the survey group, depending on which is most relevant.

**The maps show patterns in vegetation across all of Battery Park City:**






**The donut charts provide information for Battery Park City as a whole:**




*The heading indicates whether the chart includes all plants or just trees.*

*The outer ring represents the percent of all species with a given trait. In this case:*

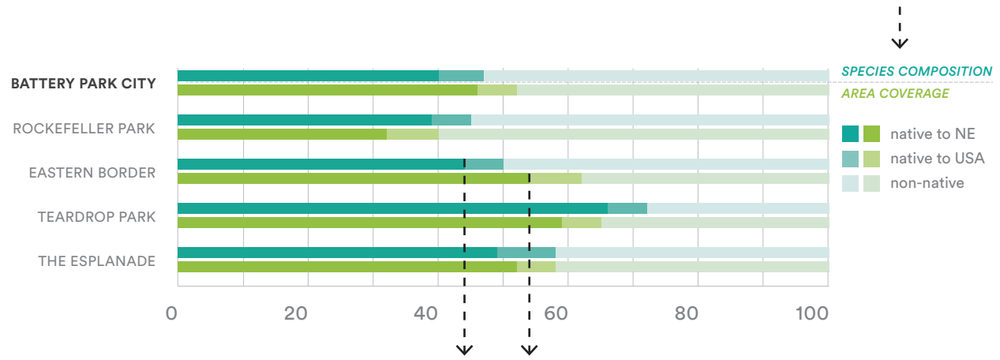
- 40% of all species are **native to NE**
- 7% of all species are **native to USA**
- 53% of all species are **non-native**

*The inner ring represents the percent of the vegetative coverage with a given trait. In this case:*

- 46% of the vegetative cover is **native to NE**
- 6% of the vegetative cover is **native to USA**
- 48% of the vegetative cover is **non-native**

**The bar charts compare information across the different areas of Battery Park City:**

*The top row shows the proportion of all species with a given trait. The bottom row shows the proportion of vegetative coverage with a given trait.*




67% of all species in the Eastern Border are **native to NE**

59% of the vegetative cover in the Eastern Border is **native to NE**

# Biodiversity

Simply put, biodiversity is the variety of all living things and their interactions. BPCA's Sustainability Plan sets goals for better understanding the patterns of biodiversity throughout the neighborhood in order to inform planning, design, and management measures to enhance overall biodiversity and set appropriate biodiversity goals for each park. The analyses in this section focus on plant and tree biodiversity findings derived from the tree and plant inventories to support these goals as well as other aims such as expanding native plantings and managing invasive species.

## GENERAL BIODIVERSITY

Battery Park City is home to many plant species. The 2023 Plant Species Inventory observed:

**902 PLANT SPECIES**

**358 NATIVE SPECIES**

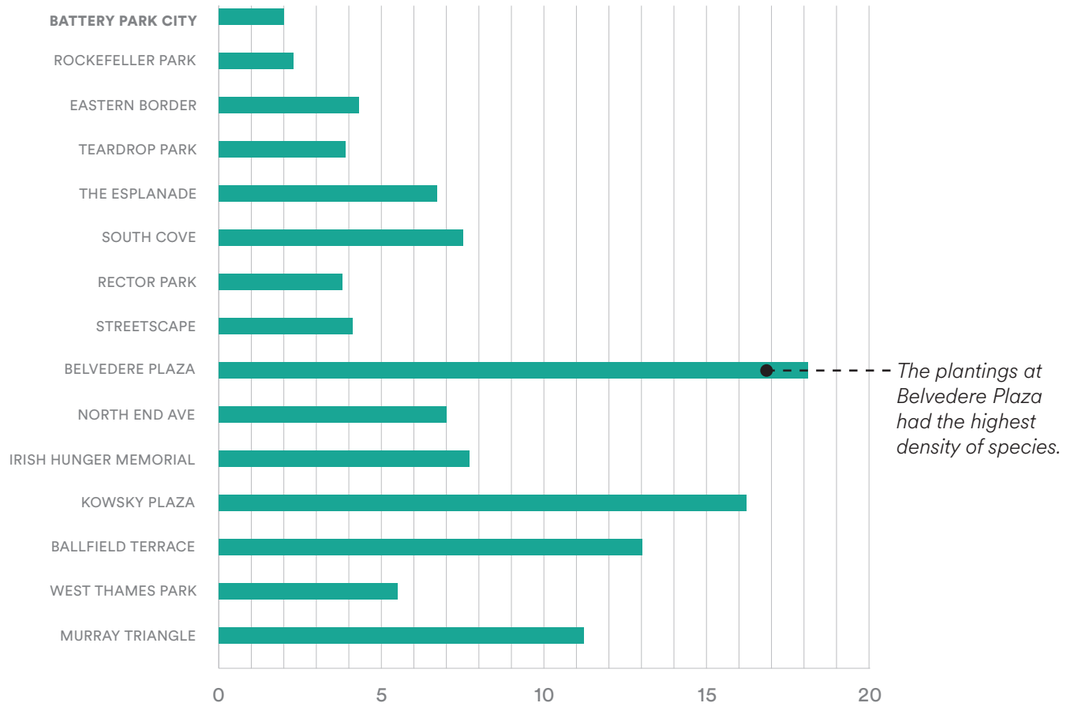
**70 SPECIES OF TREES**

The number of plant species found in BPC (902) was greater than the number of plant species identified within New York City forests based on the Natural Areas Conservancy Natural Areas Map which reports 846 unique species of plants in New York City forests—covering 10,542 acres of forest.

While plant species are documented by horticultural staff when they are planted, there were 314 plant species observed on-site




*The species richness of BPC's planted areas, shown by survey group.*




*Biodiversity indices for each area of the park, measured in species per 1,000 square feet.*

that were not documented in BPCA's existing plant lists. Many of these plants were likely established on their own. This illustrates that while BPC is a highly managed urban landscape, it is also a dynamic ecosystem.

The total number of species per acre of all vegetated area in BPC, including lawn area, was 86 species/acre (or 2 unique species per 1,000 square feet). The total number of species and species per unit area within each park varied: Belvedere Plaza was the park with the highest number of species per area (just over 18 per 1,000sf) while Rockefeller Park was the park with the lowest number (only 2.2 species per 1,000sf). The presence of species and their relative abundance is a fluid number and is the result of multiple factors including garden design goals and presence of lawn, among others. For example, the largest parks typically had lower numbers of species per area and smaller parks tended to have higher numbers of species per area. This suggests there is room to add more species into larger parks, as appropriate, and that the number of species per park is not determined by the size of the park.

Over 1,750 living trees, comprised of 70 species, were documented. There were five dominant species and almost one quarter of all of the BPC's trees were Honey Locusts. The top 5 most dominant tree species were: Honeylocust (23%), Japanese zelkova (7%), Callery pear (7%), Littleleaf linden (6%), Willow oak (6%). The most dominant non-tree species included: *Liriope spicata, Vinca minor, Rhus aromatica, Hydrangea quercifolia,* and *Eurybia divaricata.*

**BPCA should consider transitioning the quantity and coverage of overly abundant species towards species less represented throughout the park over time to increase biodiversity.**

# Common Trees and Plants

*The six most dominant trees in Battery Park City and several common perennials and shrubs.*


Japanese zelkova (6.9% of all trees)


White wood aster


Oakleaf hydrangea


Creeping Lilyturf


Callery pear (6.8% of all trees)


Willow oak (5.6% of all trees)


Honey Locust (23% of all trees)


Periwinkle


Little leaf linden (6.4% of all trees)


Fragrant sumac

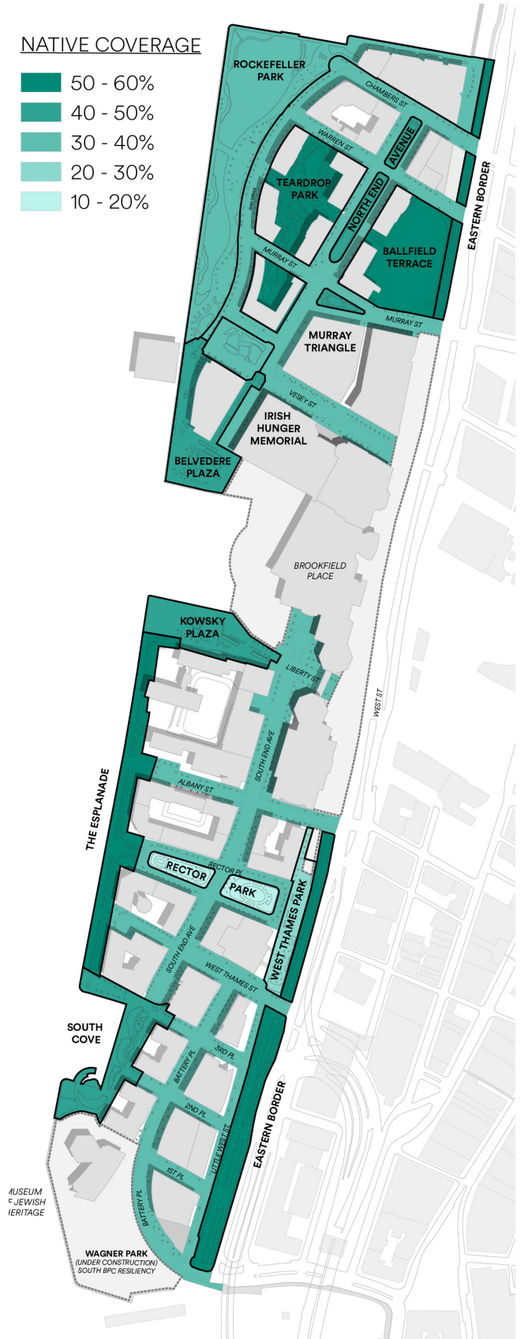
# NATIVE SPECIES

Native status refers to whether a species has evolved and occurs naturally within a particular region, ecosystem, and habitat. Native plants contribute more ecological value than non-native species, leading BPCA to set specific goals to expand native plantings. The 2023 Plant Species Inventory found 358 species native to the Northeast, comprising 40% of all plant species. These species accounted for 46% of the vegetative coverage throughout Battery Park City, and 53% of all trees.

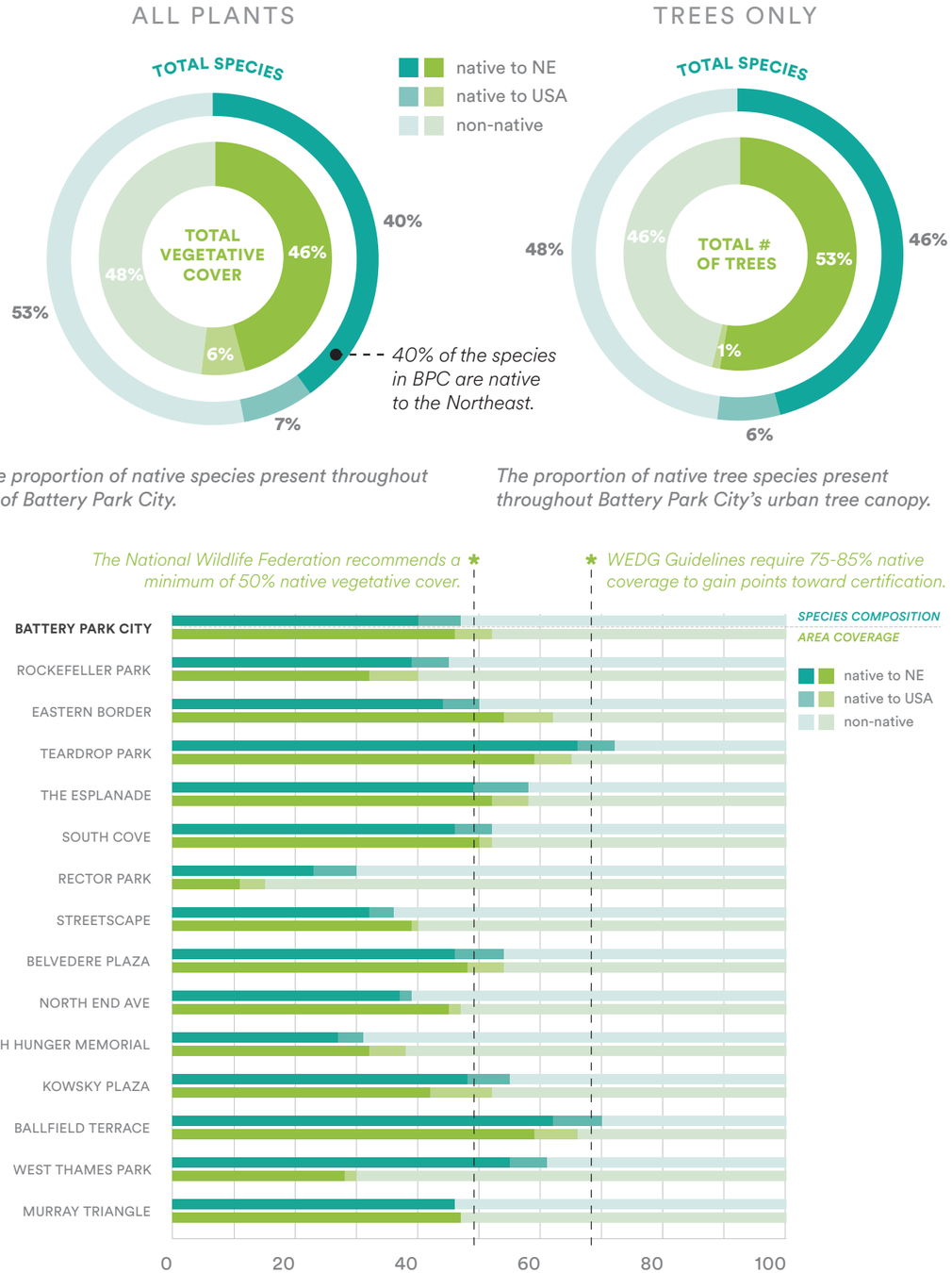
The relationship between the number of native species and their actual vegetative coverage varied from park to park. These patterns were influenced by each park's size, design, programming, and management approach. The areas with the highest number of native species included the Esplanade, Rockefeller Park, and Teardrop Park. While Teardrop Park and the Esplanade also exhibited a high percentage of native cover, Rockefeller Park had notably less native coverage given its large lawn areas and focus on active leisure. The Irish Hunger Memorial, with its focus on non-native plants endemic to the Irish countryside, had among the lowest coverage of native species.

In general, across parks, native species coverage comes close to meeting the lower thresholds of recommendations aimed at supporting local biodiversity. The National Wildlife Federation recommends planting 50-70% native species, while sustainable site guidelines like WEDG (Waterfront Edge Design Guidelines) recommend planting for 70-80% native cover.

**BPCA should work to expand native plantings in areas with <50% coverage, using areas with high native coverage (such as Teardrop Park and the Eastern Border) as models for native-forward plantings. Where possible, non-native perennials and groundcovers should be replaced with natives of similar performance and aesthetics. Non-native trees and shrubs showing decline or otherwise marked for removal can be replaced with native species.**




*The overall percent cover of native species within each individual park.*




*The proportion of native species present throughout all of Battery Park City.*

*The proportion of native tree species present throughout Battery Park City's urban tree canopy.*

*The proportion of native species in each area of BPC, presented by percentage of species and by the percent of vegetative coverage.*

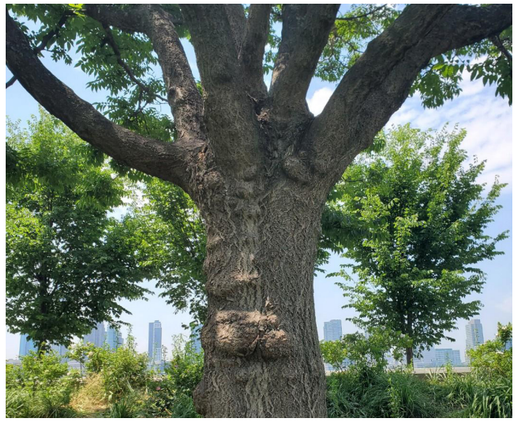
# INVASIVE SPECIES

Invasive species are organisms that spread beyond their original site of introduction and have the potential to cause harm to the environment, the economy, or to human health. They are typically aggressive and tend to out-compete local native species.

Invasive species in New York are categorized and managed regionally by Partnerships for Regional Invasive Species Management (PRISMs). In some cases, invasive species are regulated or prohibited under NY State Law. Information on invasiveness for each plant species was compiled across all PRISMs, noting that the risks associated with certain invasive species may be higher in naturalized areas than in highly managed urban areas. For example, honey locust is considered invasive in the natural areas of Long Island, but it is also a common and useful street tree in many urban areas. **The risks and approaches to invasive management should be assessed on a species-by-species level.**

Approximately 9% of the species identified are listed as invasive, comprising around 15% of the vegetative coverage. Of the 70 tree species identified, 11% are considered invasive, accounting for 32% of all trees. This number is particularly influenced by the dominance of honey locust in the canopy, and a more detailed picture of species abundance should be studied.

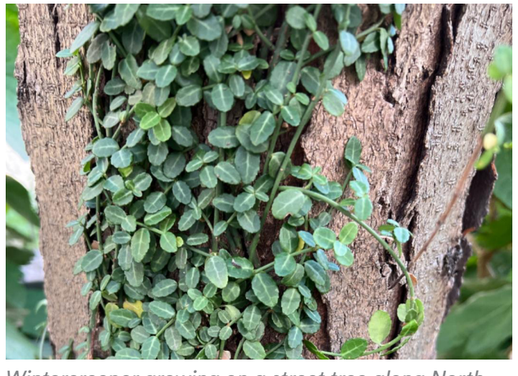
**BPCA should study the distribution and risks of each species in the park and develop an Invasives Species Management Plan to guide and prioritize management efforts. While the environmental benefits of certain invasive species (such as hardy street trees) may outweigh their ecological risks in a managed environment like Battery Park City, horticultural staff should prioritize native alternatives in all plantings where possible. Priority for removal and replacement should be given to species regulated or prohibited by NY State.**



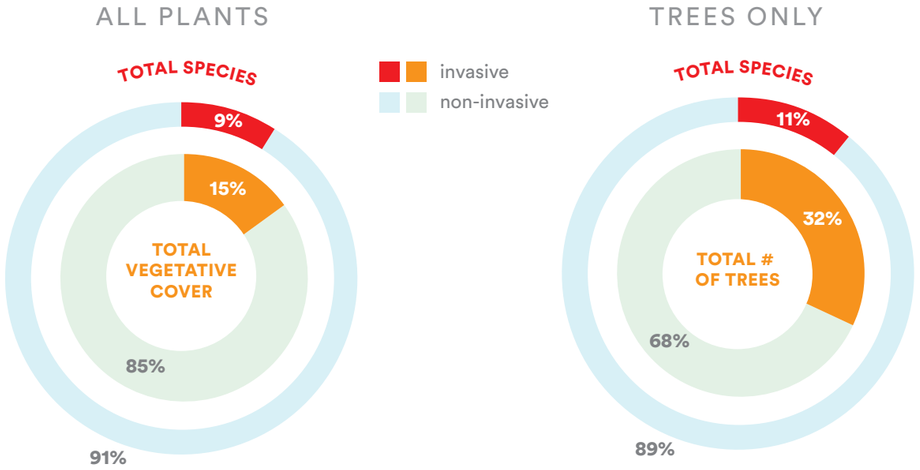
*An Amur cork tree in Rockefeller Park.*



*Common mugwort at the Irish Hunger Memorial.*



*Wintercreeper growing on a street tree along North End Avenue.*




*The proportion of invasive species present throughout all of Battery Park City.*

*The proportion of invasive tree species present throughout BPC's urban tree canopy.*

| COMMON NAME | SCIENTIFIC NAME | BOTANICAL CATEGORY | INVASIVE STATUS |
|---|---|---|---|
| Amur Cork Tree | *Phellodendron amurense* | tree | invasive - prohibited |
| Common Mugwort | *Artemisia vulgaris* | perennial | invasive - prohibited |
| Chinese Silver Grass | *Miscanthus sinensis* | graminoid | invasive - regulated |
| Wintercreeper | *Euonymus fortunei* | shrub | invasive - regulated |
| Japanese Stiltgrass | *Microstegium vimineum* | graminoid | invasive - prohibited |
| Creeping Thistle | *Cirsium arvense* | perennial | invasive - prohibited |
| Sycamore Maple | *Acer pseudoplatanus* | tree | invasive - prohibited |
| Norway Maple | *Acer platanoides* | tree | invasive - regulated |
| Japanese Knotweed | *Reynoutria japonica* | perennial | invasive - prohibited |
| Purple Loosestrife | *Lythrum salicaria* | perennial | invasive - prohibited |
| Creeping Bentgrass | *Agrostis stolonifera* | perennial | invasive - regulated |
| Black Locust | *Robinia pseudoacacia* | tree | invasive - regulated |
| Cup Plant | *Silphium perfoliatum* | perennial | invasive - prohibited |
| Common Reed | *Phragmites australis* | graminoid | invasive - prohibited |
| Common Crape Myrtle | *Lagerstroemia indica* | shrub | invasive - prohibited |
| Wineberry | *Rubus phoenicolasius* | shrub | invasive - prohibited |
| Multiflora Rose | *Rosa multiflora* | shrub | invasive - prohibited |
| Amur Honeysuckle | *Lonicera maackii* | shrub | invasive - prohibited |

*Invasive species observed in Battery Park City which are prohibited or regulated by the NYSDEC. Species are listed in descending order based on overall vegetative cover, with the highest at the top.*

# Habitat & Wildlife Value

Habitat and wildlife value refers to a plant's ability to provide food, shelter, nesting, and other habitat benefits for birds, insects, pollinators, and other types of wildlife. BPCA's Sustainability Plan includes goals for expanding and enhancing existing habitat and supporting ecological health throughout its open spaces. These goals include studying and identifying specific locations that might serve as habitat patches and corridors for various forms of wildlife. The analyses in this section explore the habitat value of the vegetation surveyed in the 2023 Plant Species Inventory and include recommendations to enhance these existing habitats.

## OBSERVED WILDLIFE

Battery Park City is home to a wide array of plant and animal species. While the 2023 Plant Species Inventory focused specifically on the plant species in the neighborhood, wildlife observations collected in iNaturalist from 2022-2023 were also reviewed to understand the existing wildlife in the area and to inform recommendations around habitat enhancement. The wildlife observations from 2022-2023 included:

**412 TOTAL SPECIES**

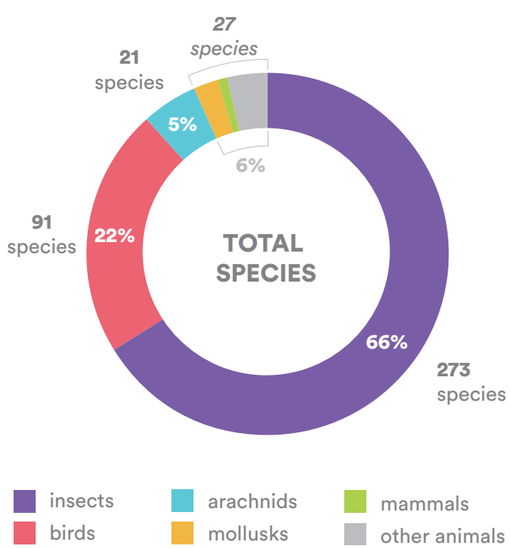
**273 INSECT SPECIES**

**91 BIRD SPECIES**

These wildlife observations were made by citizen scientists and other self-selected volunteers so do not reflect a systematic inventory of wildlife, but can still provide a wealth of information about what wildlife is found in Battery Park City.

Insects were by far the most observed category of wildlife. Insect observations included 50 different species of butterflies and moths, as well as many different types of bees (including 2 specialist bee species).

Birds were the next most observed category of wildlife, with variation in the species observed depending on the season. Battery Park City sits along the Atlantic Flyway, a migratory route used by millions of birds to move between their nesting and overwintering grounds. Many birds use Battery Park City as refuge along their migratory journeys, while others use it as breeding grounds or a safe place to overwinter.




*Wildlife observed in Battery Park City from 2022-2023. (Source: iNaturalist)*

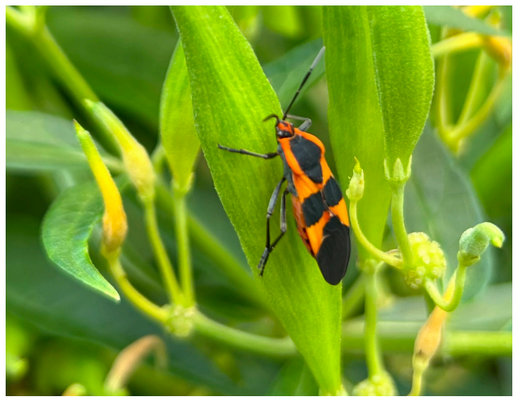
Other wildlife observed included arachnids (spiders), mollusks, mammals, and fish.

**BPCA should continue to encourage and promote the use of iNaturalist, conduct BioBlitzes, and engage citizen scientists in documenting wildlife observations. However, many important wildlife species are difficult to observe and identify in the field, such as specialist bees or nocturnal moths. To gain a better picture of the wildlife in the park, it is recommended that Battery Park City conduct dedicated species inventories in partnership with trained ecologists.**

The other analyses in this section are based on the plant and tree inventories performed in 2023 based on their documented wildlife value and can be used to help identify areas of high habitat quality for certain types of wildlife and point toward locations for further focused study. Battery Park City staff should also compare these analyses with their own field observations, documenting relationships between plants and animals to update wildlife value information for the species in the park as it becomes available.




*A map of the Atlantic Flyway route used by migratory birds. (Source: National Science Foundation)*



*A large milkweed bug (Oncopeltus fasciatus) feeding on some swamp milkweed. (Source: BPCA)*



*A ruby-throated hummingbird (Archilochus colubris) feeding in Rockefeller Park. (Source: iNaturalist)*

# Habitat & Observed Wildlife

*Species of birds and insects observed in Battery Park City and some of the vegetation that supports them.*

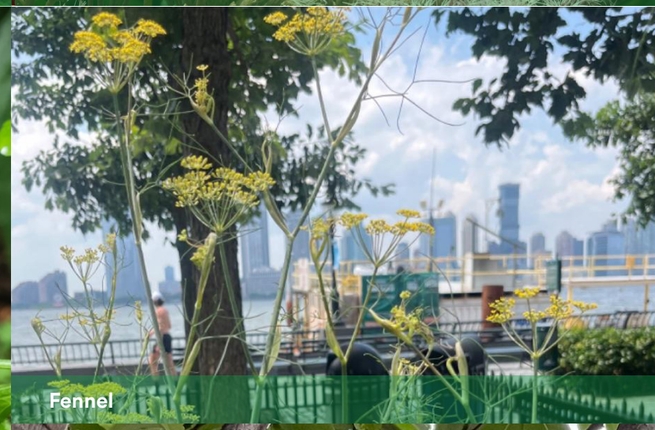

Common Milkweed


Monarch


Swamp milkweed


Eastern tiger swallowtail


Black swallowtail


Fennel


Yellow-bellied sapsucker


Butterflyweed


Willow oak


Scarlet tanager

# HABITAT FOR BIRDS

Plants help support bird species across seasons by providing fruit, nectar, and other food sources as well as nest material, nesting habitat, and shelter from predators. Plant species in Battery Park City were assessed for their ability to provide significant habitat value for birds in any of the ways listed above. Almost half of the species in BPC provide significant benefits for birds, accounting for 60% of all vegetative cover. Trees are of particular value for birds and almost 80% of the trees in the park are known to be of significant value to birds.

Vegetation supporting birds varied from park to park, but most parks were found to have at least 50% of their vegetative cover in support of birds. Complex, multi-layered plantings help provide a high density of habitat niches for different birds across multiple vegetative strata, supporting both ground and canopy nesting species in the same area. The Esplanade, with its consistent canopy and large, protected, multi-layered planting beds, was found to have the highest vegetative coverage in support of birds, and may be a good site to conduct a more focused bird inventory.

Certain areas, like Rector Park and Teardrop Park, are considered favorite spots for many local birdwatchers. While Rector Park was found to have relatively low coverage of bird-supporting species, it may be providing additional habitat value not captured in this analysis. It's also possible that its open layered canopy and clear ground plane simply allow for easier bird observation when compared to denser, more protected sites.

Dedicated bird species surveys and field observations can help to ground-truth or enhance the conclusions of this analysis. For example, while the coverage of bird-supporting species at the Irish Hunger Memorial was observed to be among the lowest in Battery Park City (likely due to the lack of trees), the field team observed a pair of nesting mallards while conducting field work. Given its meadow-style planting, heavily protected planted areas, and proximity to the Lily Pond, the memorial may represent good duck nesting habitat. This supports the conclusion that while complex, multi-layered plantings provide a high density of habitat niches for birds, other habitat typologies such as meadows or wetlands also contribute to overall bird habitat in significant ways and should be considered in management and design initiatives.

**Potential actions to enhance bird habitat include adding more freshwater sources within planted areas, planting trees and shrubs with extensive fruiting periods, distributing evergreen species to provide winter shelter, and planting native species in masses and clusters to support more robust foraging.**

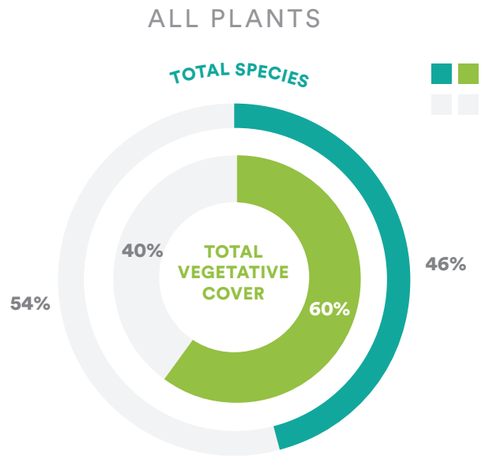


*An orange-crowned warbler rests on a low branch along the Esplanade. (Source: iNaturalist)*

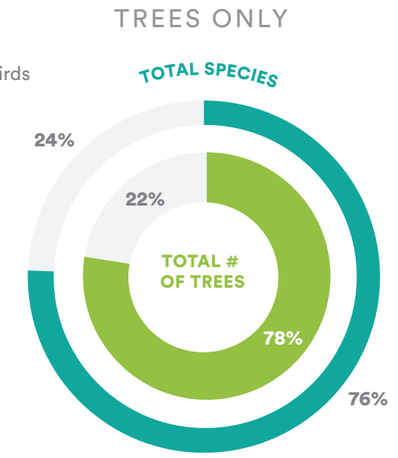


*A group of sparrows forages in the grasses atop the Irish Hunger Memorial. (Source: iNaturalist)*

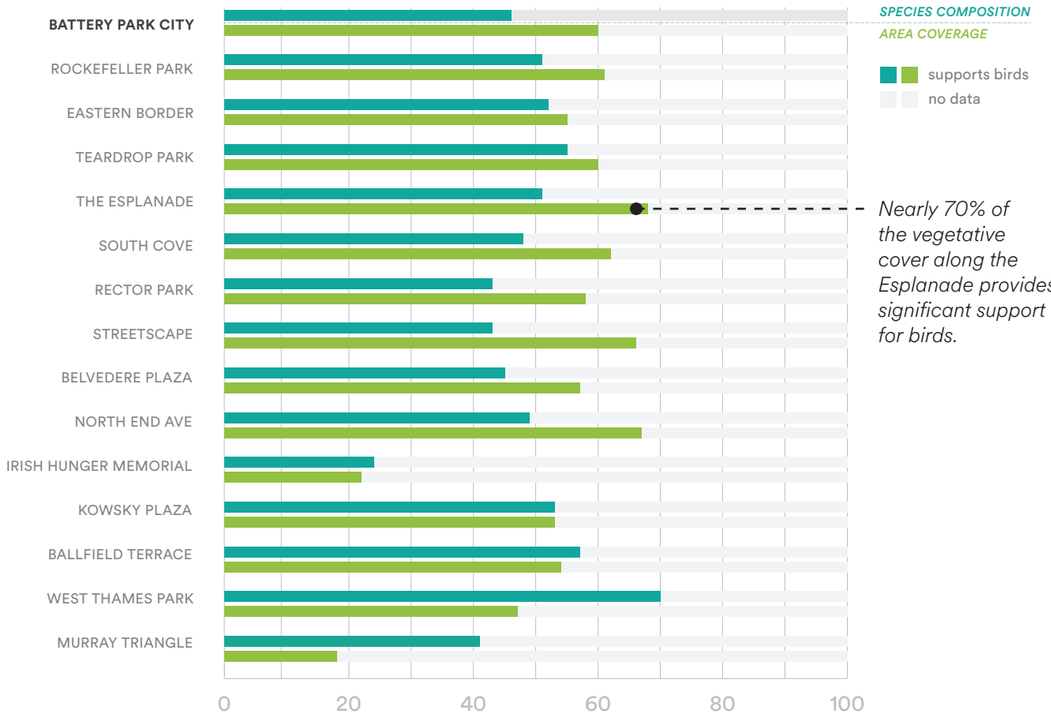





*The proportion of vegetation throughout BPC known to provide significant support for birds.*




*The proportion of trees throughout BPC known to provide significant support for birds.*




*The proportion of vegetation supporting birds in each area of BPC, presented by percentage of species and by the percent of vegetative coverage.*

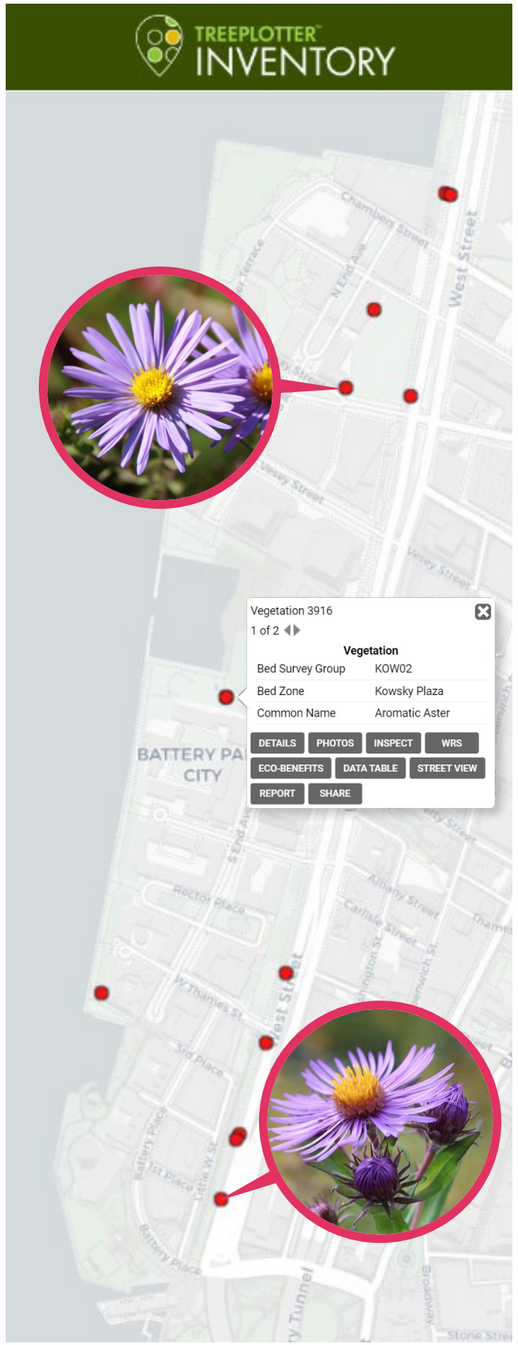
# BLOOM PERIOD

Flowering plants provide important food sources for insects, birds, and other pollinators. Bloom period refers to the average period of a time annually that a particular species is actively flowering. In addition to providing aesthetic value, planting a variety of species that bloom in succession across different seasons helps ensure that pollen and nectar resources are available to pollinators all year round. The typical documented bloom period for each plant species in the park was analyzed to create a bloom calendar for Battery Park City.

The number of species typically in bloom in Battery Park City ranges from 11 species in December up to 426 species in June. Five park areas—Rockefeller Park, the Eastern Border, Teardrop Park, South Cove, and North End Avenue—were observed to contain a mix of species that provide blooms year-round.

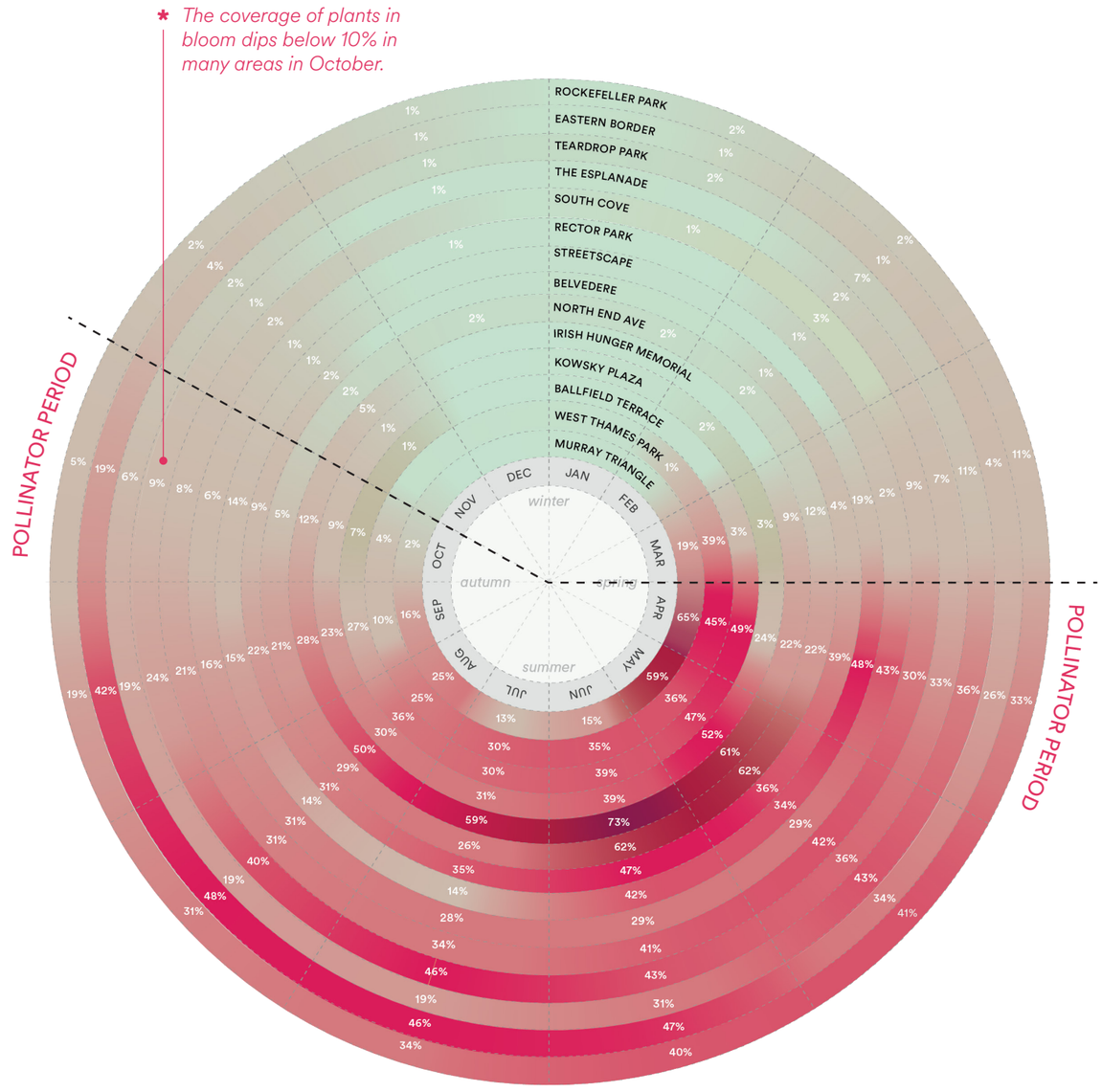
The pollinator period from April to October is a particularly important time of year when pollinators are most active. While a robust number of species in bloom throughout most of these months were observed, the coverage of blooming species in October was notably low. The Xerces Society recommends at least 10% coverage of native blooming plants at all times throughout the pollinator period, suggesting there is a need to plant more late-season blooms to better provide pollinator resources at the crucial moment before many species overwinter.

**BPCA should continue to monitor species bloom periods in conjunction with microclimate and update information as necessary. Given that rising temperatures may shift phenological patterns, updates may be required with increasing frequency. Horticultural staff should also work to incorporate flowers of a variety of colors and shapes to attract a wide diversity of pollinators.**




*The locations of October-blooming aromatic aster (Symphyotrichum oblongifolium), shown in TreePlotter.*

* *The coverage of plants in bloom dips below 10% in many areas in October.*




*The seasonal distribution of blooms within each park across spring, summer, fall, and winter.*

# HABITAT FOR SPECIALIST INSECTS

Specialist bees, butterflies, and moths are insects which have evolved to feed on specific plants to complete their lifecycle. These insects play critical roles in ecosystems, helping pollinate native plants and providing essential food for birds and other wildlife. Because of their specialized symbiotic relationships, they are also at a higher risk of decline and extinction when faced with habitat fragmentation and loss of their host species.

Around half of the plant species in Battery Park City are known to provide support for specialist insects. Native trees are particularly important, and approximately 70% of the tree species in Battery Park are known to support specialist insects. However, these species make up only 52% of the total trees.

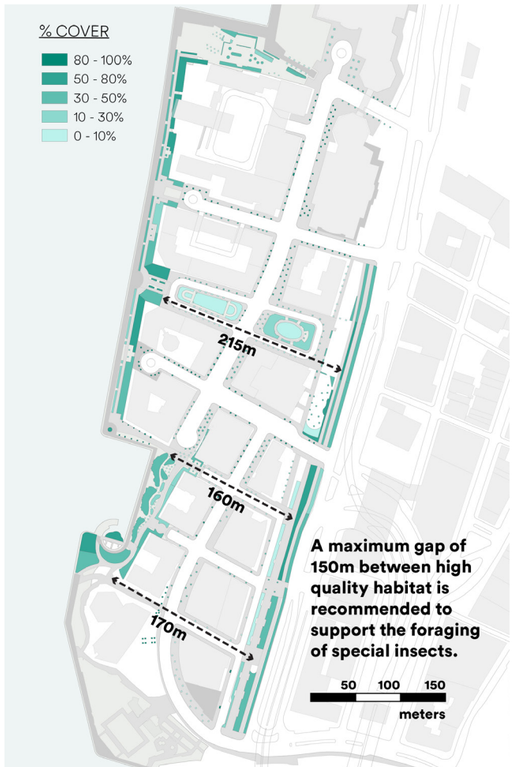
The plantings at the Ballfield Terrace feature a high concentration of native plants and were found to have the highest percent coverage of plants supporting specialist insects. Though relatively small in area, they may serve as a model for expanding specialist insect habitat throughout the neighborhood. While the Irish Hunger Memorial is designed largely to feature non-native plants endemic to the Irish countryside, it too was found to have a high concentration of supportive plant species. While native plants often support more insect species than non-native plants, this finding suggest that careful selection of non-native species can still provide some ecological benefit.

Many smaller insects are only able to fly short distances to forage for pollen and nectar, so habitat connectivity is key and large gaps between supportive planted areas can be a barrier to survival and movement.

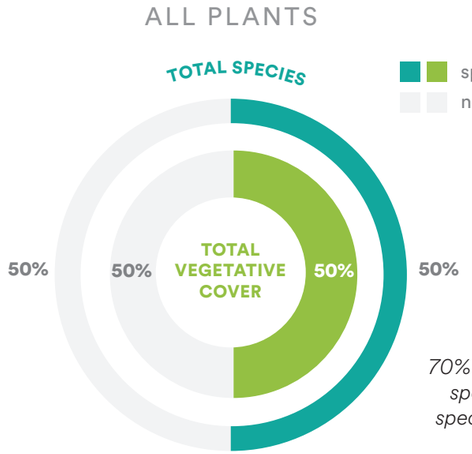
**Actions to enhance habitat include better connecting pollinator corridors like The Esplanade and Eastern Border to allow more species to move and thrive throughout the neighborhood. New tree plantings should focus on native keystone species.**



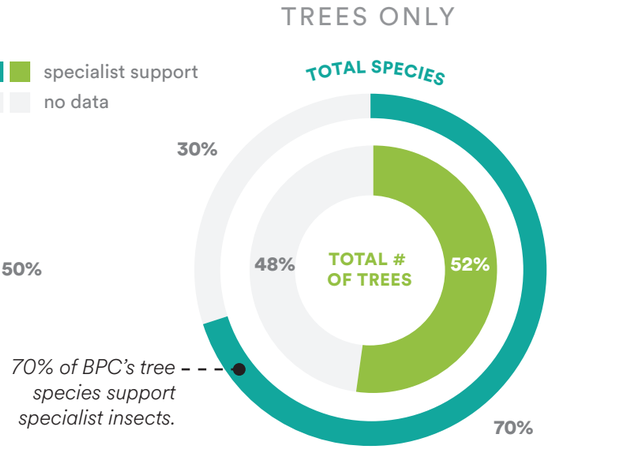
*A monarch butterfly (Danaus plexippus) visits its host plant, swamp milkweed (Asclepias incarnata).*



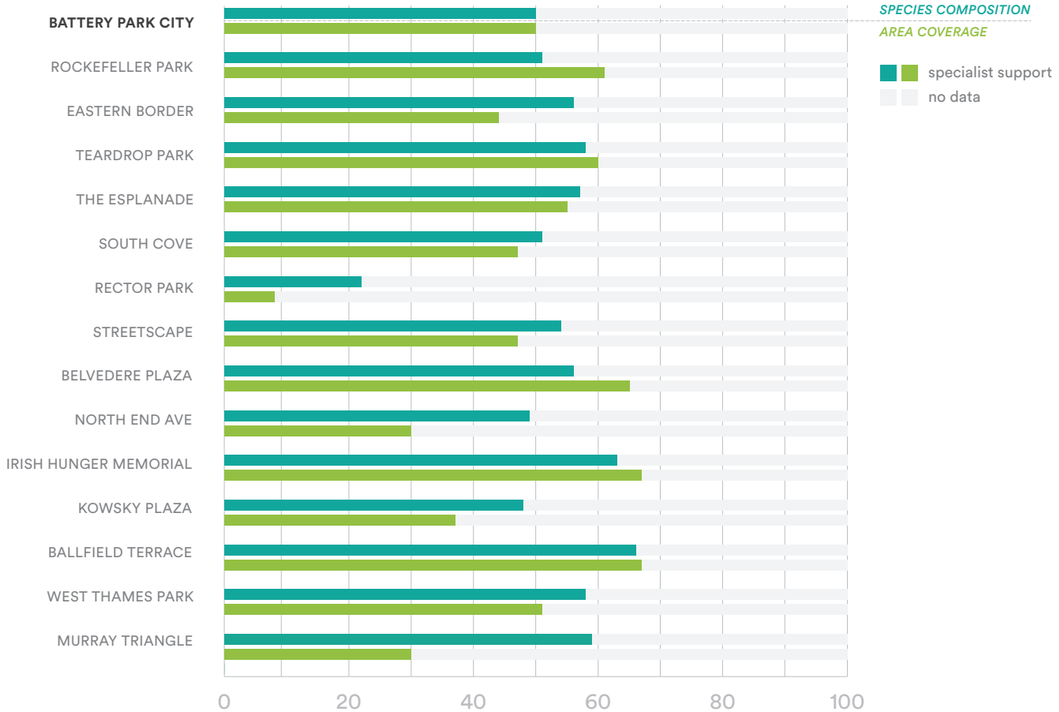

*The percent cover of specialist-supporting vegetation, with gaps in habitat connectivity called out.*




*The proportion of vegetation throughout BPC known to support specialist insects.*




*The proportion of trees throughout BPC known to support specialist insects.*




*The proportion of vegetation supporting specialist insects in each area of BPC, presented by percentage of species and by the percent of vegetative coverage.*

# Resiliency

## GENERAL FINDINGS

For this analysis, resiliency focused on the ability of vegetation to survive and thrive in the face of environmental stressors and climate change, as well as the ability of trees to improve Battery Park City's adaptive capacity to urban heat island effects. Tree and plant species' environmental tolerances to specific stressors including drought, flood inundation or saturation, salt, and high emissions (for trees only) were examined. These environmental stressors are likely to become more frequent and extreme with climate change.

Other resilience factors such as sun and shade tolerance, hardiness zone, and C-Value (a metric for tolerance to disturbed sites) were also collected for each species but were not analyzed as part of this project. These characteristics can be used in future analysis related to resiliency. For example, hardiness zone data can be used to inform tolerance to future warmer weather. As hardiness zones are predicted to shift with climate change, some plants traditionally hardy in New York City may be at risk of stress or mortality from higher temperatures.

### MANAGING A RESILIENT LANDSCAPE COMPREHENSIVELY

The following pages describe detailed results and recommendations based on the analysis of drought, saturation, and salinity tolerance patterns. Each of these subject areas suggests a **need for a unified Resilient Landscape Management Plan** to address the inter-relationships among environmental stressors and improve adaptive capacity holistically. For example, maintenance measures for drought and freshwater saturation may involve modifications to drainage and irrigation and should be considered in tandem. Improving drainage in one area may alleviate a condition of too much saturation but could consequently create a new condition where soils drain too quickly during periods of drought.

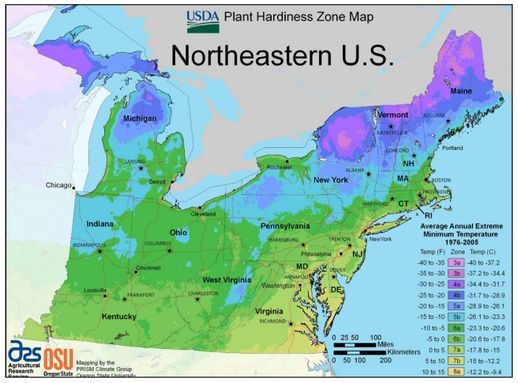
### UNDERSTANDING EXPOSURE AND VULNERABILITY

In addition to developing a comprehensive management approach for multiple environmental stresses, understanding the exposure and vulnerability of these stresses to drought, saturation, and salinity in site-specific areas would allow Battery Park City to make informed management decisions and improve site resilience. The species-specific characteristics provided as part of this project provides data on how adaptive a species and planting area may be. However, understanding the frequency and extent of exposure to these stressors over time within site-specific areas would allow the development of measurable management targets and actions to improve resilience. As such, **a BPC site-wide exposure and vulnerability mapping for drought, stormwater and compound flooding, and salinity is recommended.**

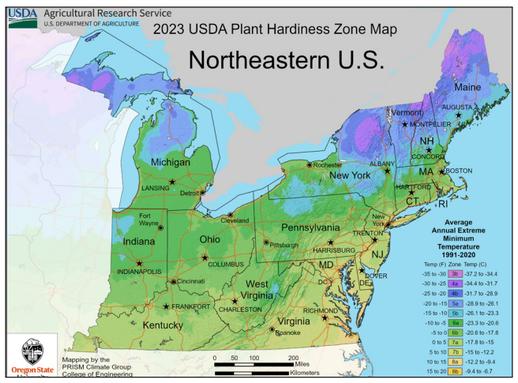
### DEALING WITH UNKNOWNS IN PLANT CHARACTERISTICS

The study of climate-related stresses and conditions is relatively under-studied in the fields of horticulture, urban ecology, and landscape architecture. Several categories of analysis lacked data for many species. Categories with unclassified species included: Drought tolerance (156 species unclassified (17% of total)); Saturation tolerance (504 species unclassified (54% of total)); Salt Spray tolerance (708 species unclassified (56% of total)); Saltwater Inundation tolerance (820 species unclassified (89% of total)); and Salty Soil tolerance (659 species unclassified (51% of total)).

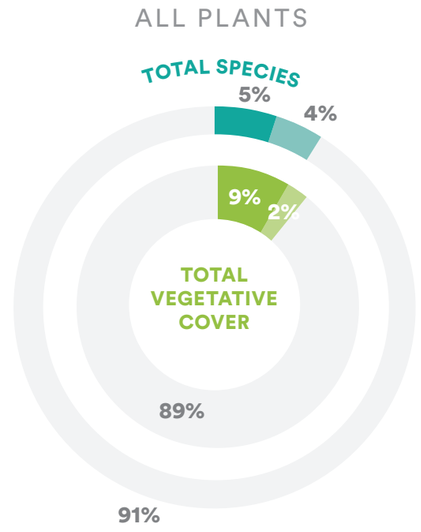
**BPCA should use the tools within TreePlotter to document, monitor, and adapt landscape management practices in response to observations of signs of stress or tolerance for species with unknown classifications.** Additional discussions with the Horticulturalist team to discuss observations of resiliency and patterns related to plant stress or tolerance can inform management decisions. Battery Park City should also consider partnerships with research or academic entities to further complete the category classifications for all species.




*USDA Plant Hardiness Zone Map, 2012. Source: U.S. Department of Agriculture.*




*USDA Plant Hardiness Zone Map, 2023. Source: U.S. Department of Agriculture.*




*Saltwater inundation data has the highest percent of unknown data, which includes 91% of all plant species.*

# Resilient Plants



Swamp rose mallow

*Common species in Battery Park City that are tolerant to all three environmental stressors: drought, flooding/ saturation, and all three types of salt stress.*



Swamp white oak



Canadian serviceberry



Arrowwood viburnum



Summersweet



Black gum



Seaside goldenrod



Gray birch



Switchgrass



Inkberry

# DROUGHT TOLERANCE

Drought tolerance refers to the degree to which a plant can withstand periods of drought or low precipitation/watering. Droughts are extended periods (at minimum, a few weeks or months) with lesser than average rainfall for a specific area. When considering drought tolerance, the vegetative coverage is a significant factor to consider based on the risk that large areas of vegetation could die during periods of low rainfall which would be costly to replant and undesirable.

A total of 77% of the vegetive coverage in Battery Park City had at least medium tolerance (64%) or high tolerance (13%) to drought suggesting that most planted areas in Battery Park City have a fair degree of resilience to drought. Out of the trees observed in Battery Park City 90% (1,582 trees) are considered to have medium  to high drought tolerances. However, there were areas and species with low drought tolerance: 17% of the total vegetative coverage in BPC had low drought tolerance (comprised of 205 species) and 167  trees (9.5%) consisting of 11 species had low tolerances to drought.

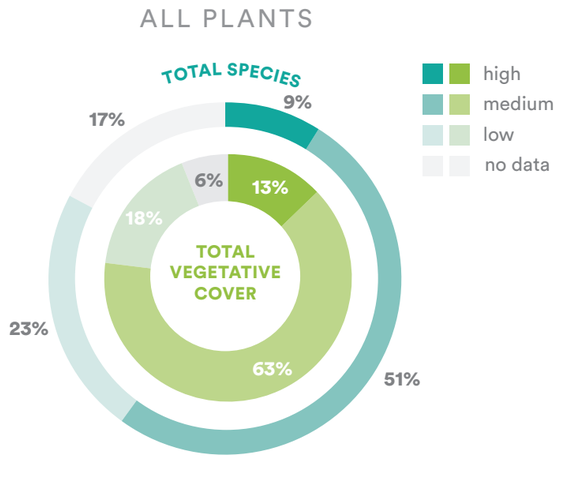
Teardrop Park, had the highest percent of vegetated area with low drought tolerance (27% of vegetated area, consisting of 64 species), however, this park is comprised of multi-layered planting within large areas of shade which helps to reduce heat exposure and suggests additional factors beyond the single species classification should be considered when assessing vulnerability of planting beds to drought.

As the impacts of climate change become more severe, it is expected that drought conditions in New York will continue to increase in frequency and intensity.  With temperatures increasing, precipitation patterns changing, and extreme weather becoming more frequent, the planting of drought tolerance trees will be more important for developing a resilient landscape.

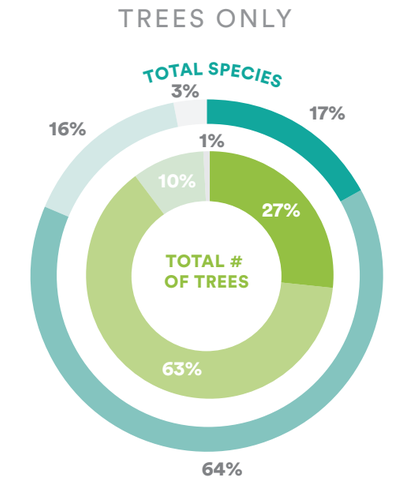
**Areas and species within BPC that have low drought tolerance should be monitored and managed during droughts. Better understanding the locations that are vulnerable to drought and creating a plan for increasing the vegetative cover of highly drought-tolerant plants in areas of concern will improve BPC resilience. Additionally, calibrating the park irrigation systems to the water saturation tolerance or non-tolerance for planting beds, or providing temporary tree water bags will improve the capacity for vegetation to survive in periods of drought.**

| COMMON NAME | SCIENTIFIC NAAME | BOTANICAL CATEGORY | DROUGHT TOLERANCE |
|---|---|---|---|
| Honeylocust | *Gleditsia triacanthos* | tree | high |
| Sweetbay Magnolia | *Magnolia virginiana* | tree | high |
| Sawtooth Oak | *Quercus acutissima* | tree | high |
| White snakeroot | *Ageratina altissima* | shrub | high |
| Arkansas bluestar | *Amsonia hubrichtii* | graminoid | high |
| Eastern Redbud | *Cercis canadensis* | tree | low |
| Allegheny serviceberry | *Amelanchier laevis* | tree | low |
| Cornelian cherry | *Cornus mas* | tree | low |
| Ostrich Fern | *Matteuccia struthiopteris* | perennial | low |
| Canadian wild ginger | *Asarum canadense* | perennial | low |

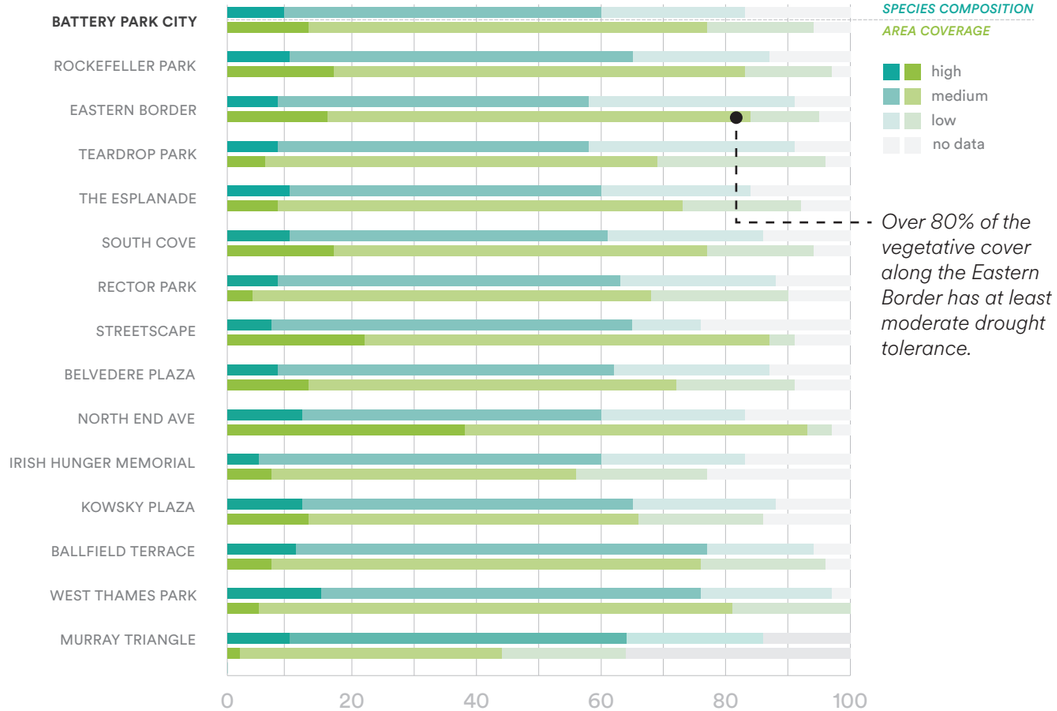
*Most common species with high drought tolerance found in Battery Park City, as well as the most common species with low drought tolerance found in Battery Park City.*




*The breakdown of drought tolerance for all species throughout Battery Park City.*




*The breakdown of drought tolerance for all trees within Battery Park City.*




*The proportion of drought tolerance for BPC overall and  in each park area, presented by percentage of species and by area coverage. Note: Drought tolerance was unknown for 156 species (17% of all species).*

# FLOOD/SATURATION TOLERANCE

Flood/saturation tolerance refers to a plant's ability to withstand soils saturated by freshwater, either from rain events, irrigation, or natural wet soil conditions. As more frequent and intense storms bring more rainfall to the New York region due to climate change, saturation tolerant species will likely perform better in wetter conditions often formed in low-lying and poorly drained areas.

For the project analysis, the National Wetland Plant List classifications maintained by the USACE were used to group wetland plant classifications into two categories: those that are tolerant of saturation (classifications of OBL, FACW, and FAC), and those that are non-tolerant to saturation (classifications of FACU and UPL) to describe the tolerance of frequent or long-lasting soil moisture conditions.

The vegetative coverage of known saturation tolerant species was fairly similar (between 20-40%) across all parks suggesting that there was a good distribution of saturation tolerant species throughout BPC. However, the significant lack of data for many species observed makes it challenging to evaluate overall saturation tolerance/non-tolerance. Approximately half (56% or 509 species) of the species in BPC lack data on their saturation tolerance. As more data is available, the database can be updated with saturation tolerance.

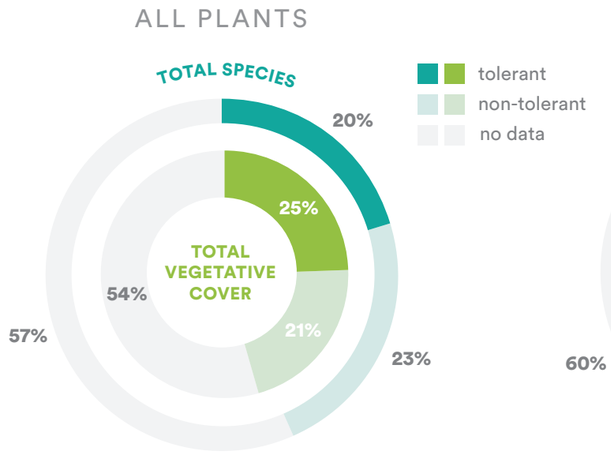
**Inland flooding and drainage issues were not identified as part of this project, but this information would assist BPCA in understanding if there are planting beds that are more or less likely to flood and retain water with increasing wet weather.**

**In planting beds with irrigation, if BPCA observes that plants are struggling in a planting bed after over 14 days of consecutive rainfall, a review of the plant list and saturation tolerance could assist in planning for changes to the irrigation regime or planting bed restoration and plant substitutions if necessary.**

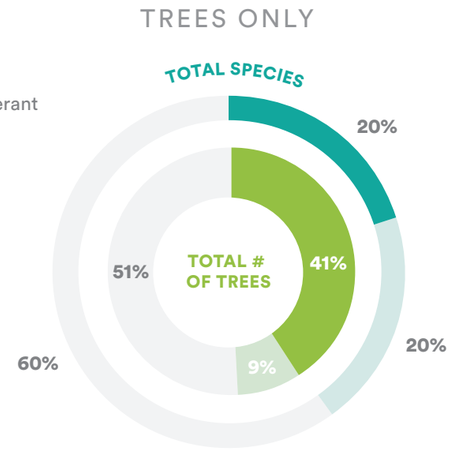
**Future study could include aligning wet weather conditions understanding with the BPC Climate Action Plan and the latest projections for future inland rainfall conditions, cloudburst conditions, and expected future landscape management practices.**

| COMMON NAME | SCIENTIFIC NAAME | BOTANICAL CATEGORY | SATURATION TOLERANCE |
|---|---|---|---|
| Honeylocust | *Gleditsia triacanthos* | tree | tolerant |
| Willow Oak | *Quercus phellos* | tree | tolerant |
| Swamp White Oak | *Quercus bicolor* | tree | tolerant |
| Winterberry | *Ilex verticillata* | shrub | tolerant |
| Northern Bayberry | *Myrica pensylvanica* | shrub | tolerant |
| Red Oak | *Quercus rubra* | tree | non-tolerant |
| Shingle Oak | *Quercus imbricaria* | tree | non-tolerant |
| Eastern Redbud | *Cercis canadensis* | tree | non-tolerant |
| White snakeroot | *Ageratina altissima* | perennial | non-tolerant |
| Wild petunia | *Ruellia humilis* | perennial | non-tolerant |

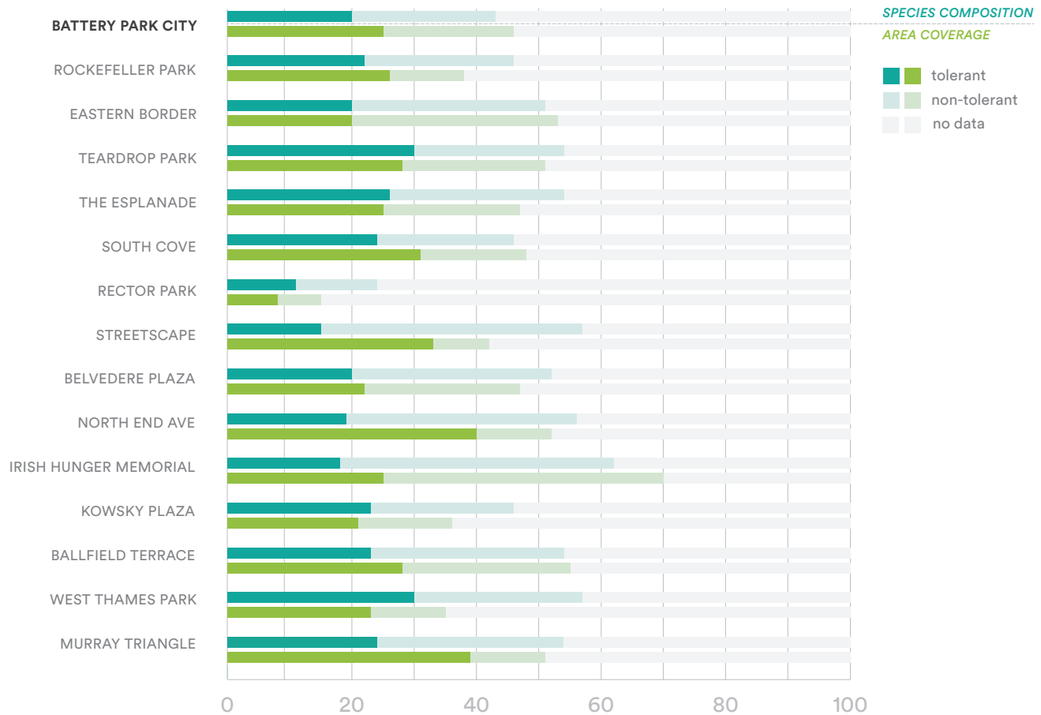
*The most common species that are flood/saturation tolerant found in Battery Park City, as well as the most common species that are non-tolerant to flood/saturation found in Battery Park City.*




*The proportion of flood/saturation tolerant species present throughout all of BPC.*




*The proportion of flood/saturation tolerant tree species present throughout BPC's urban tree canopy.*




*The proportion of flood/saturation tolerance for BPC overall and in each park area, presented by percentage of species and by area coverage. Note: Saturation tolerance was unknown for 509 species (56% of all species).*

# SALINITY TOLERANCE

The Battery Park City Sustainability Plan includes actions to “replace/protect saline-vulnerable plantings in the 100-year floodplain by 2024;” “phase out plant species that are not adapted to changing climate / hardiness zone,” and “consider salinity-resilience in park plantings.” With increasing sea levels, BPC will need to anticipate and plan for increasing conditions of salt spray, saltwater inundation, and salty soils within BPC waterfront parks. Additionally, areas exposed to roadway de-icing salt, such as the Eastern Border and the Streetscape are also exposed to salt.

Tolerance to salinity was assessed using three metrics: salt spray, saline soils, and saltwater inundation. Salt spray tolerance refers to a plant’s ability to withstand exposure to airborne salt from nearby coastlines or roadways. Saline soils tolerance refers to a plant’s ability to withstand exposure to salt within the soil, typically associated with deicing of sidewalks and roadways. Saltwater inundation tolerance refers to a plant’s ability to withstand prolonged inundation of saline water, typically as a result of storm surge or wave action along coastlines.

Of the plant species with data, 29-45% of the vegetative coverage in BPC’s waterfront parks had  tolerance to salt spray. Further research is needed to understand whether this percentage of salt spray tolerant planting is high enough to provide enough adaptive capacity for a resilient planting or if this is low and leaves the landscape vulnerable and at risk.

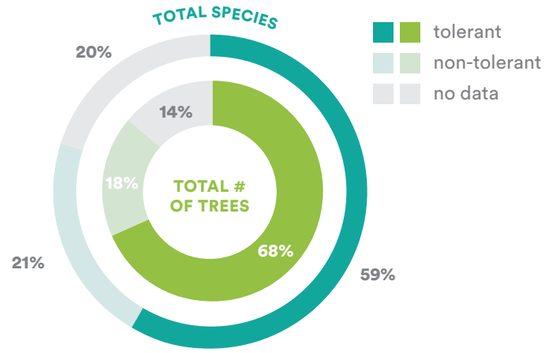
**BPCA should begin to phase out non-salt-tolerant species and increase coverage of salt-tolerant planting in exposed areas such as waterfront parks, streetscapes, and the Eastern Border. In the absence of a complete plant database on salt tolerance, BPCA can use TreePlotter to document and monitor species with unknown rankings to organize observed signs of stress and inform adaptive management standards.**

Future study could include a review of best practices and industry recommendations for resilient coastal urban landscapes to establish percent coverage targets for planting vegetation tolerant to salt spray, salt inundation, and saline soils. Saline tolerance is especially important within areas of future potential coastal storm surge and flooding. BPC should recommend saline tolerant planting in areas of likely future exposure (outside the proposed flood barrier systems) in coordination with the Battery Park City Resiliency projects currently under construction or in design.

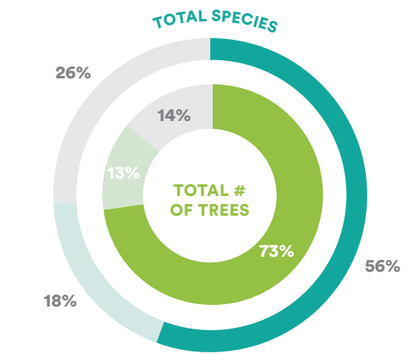
| COMMON NAME | SCIENTIFIC NAAME | BOTANICAL CATEGORY | SALINITY TOLERANCE |
|---|---|---|---|
| Honelocust | *Gleditsia tricanthos* | tree | salt spray tolerant |
| Swamp white oak | *Quercus biocolor* | tree | salt inundation tolerant |
| Willow oak | *Quercus phellos* | tree | saline soil tolerant |
| Eastern Red Columbine | *Aquilegia canadensis* | perennial | salt spray tolerant |
| Inkberry | *Ilex glabra* | shrub | salt inundation tolerant |
| Ginko | *Ginkgo biloba* | tree | salt spray intolerant |
| Allegheny serviceberry | *Amelanchier laevis* | tree | salt inundation intolerant |
| Littleleaf linden | *Tilia cordata* | tree | saline soil intolerant |
| Panicle Hydrangea | *Hydrangea paniculata* | shrub | salt spray intolerant |
| Bottlebrush Buckeye | *Aesculus parviflora* | shrub | salt inundation intolerant |

*Most common species that are tolerant to salinity in one of three ways found in Battery Park City, as well as the most common species that are intolerant tolerant to salinity in one of three ways found in Battery Park City.*

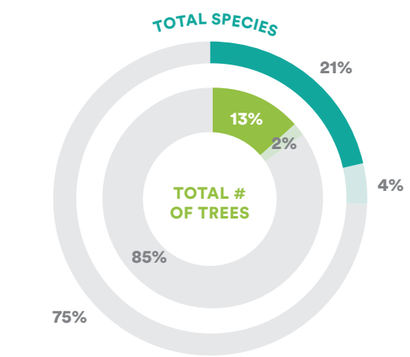
SALT SPRAY TOLERANCE *(TREES)*



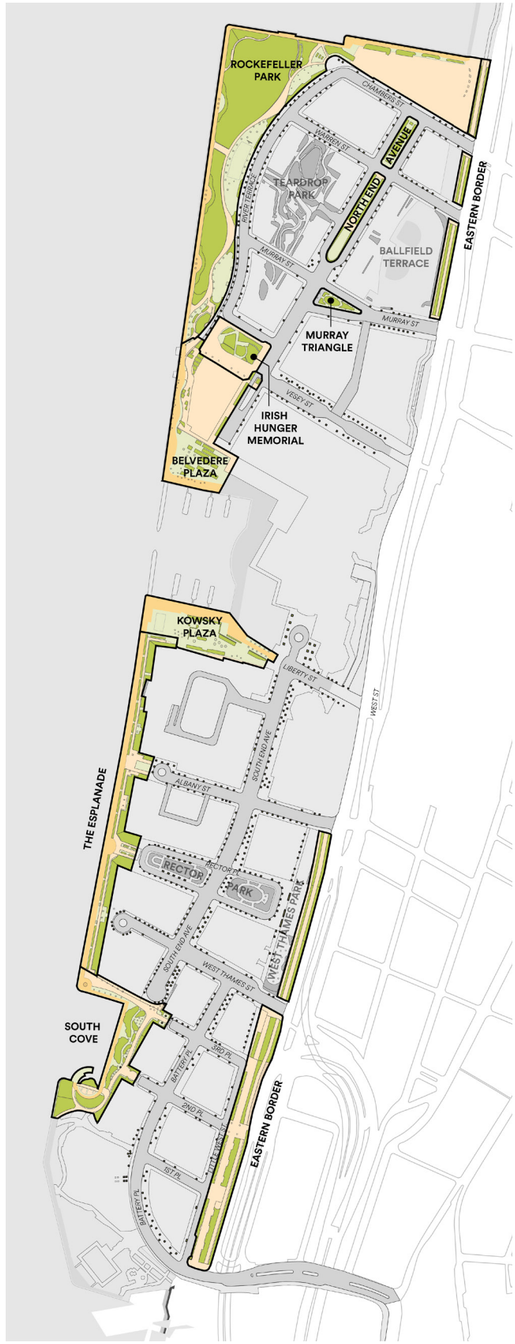

SALTY SOIL TOLERANCE *(TREES)*




SALTWATER INUNDATION *(TREES)*




*The proportion of trees in BPC with salt spray, salty soils, and saltwater inundation tolerance.*




*Areas adjacent to the waterfront and roadways are exposed to salt in some way to varying degrees.*

# CLIMATE VULNERABILITY

*(Trees Only)*

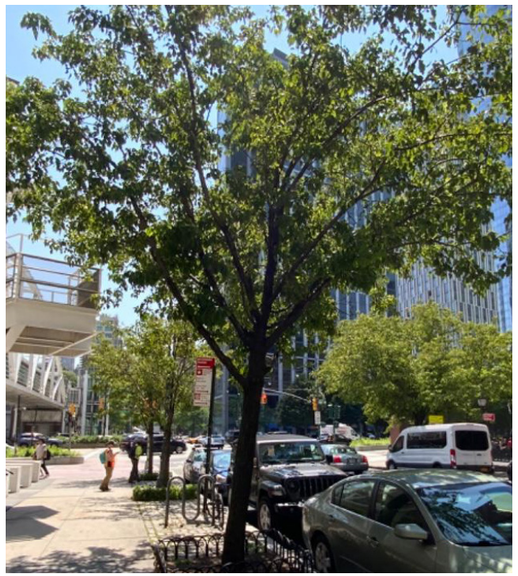
Climate vulnerability refers to a plant's susceptibility to climate change-related stressors predicted for an area, such as intense heat, drought, flooding, and changing pest and disease patterns. For the project analysis, the consultant team used the Northern Institute of Applied Climate Science (NIACS) and United States Forestry Service's (USFS) Climate Change Atlas (calculated for natural areas) tree adaptability scores to better understand BPC's tree species adaptability/vulnerability tolerances. This data only exists for trees, so only trees are included in this analysis. Climate vulnerability scores for trees are listed for both low (Representative Concentration Pathway [RCP] 4.5) and high (RCP 8.5) carbon emission scenarios. This project examines high carbon emission scenarios.

Of the 70 species of trees, 42 species (60%) had available data on carbon emissions vulnerability. Trees that are considered tolerant of high carbon emissions are those represented by the "Low" vulnerability category (10 species or 14% of the total number of trees [247 trees]) and "Low-Moderate" (10 species or 35% of the total number of trees [617 trees]) vulnerability category. With these two categories combined, the trees with a high tolerance to carbon emissions include 20 tree species, representing 49% of the total number of observed trees, or 864 trees.

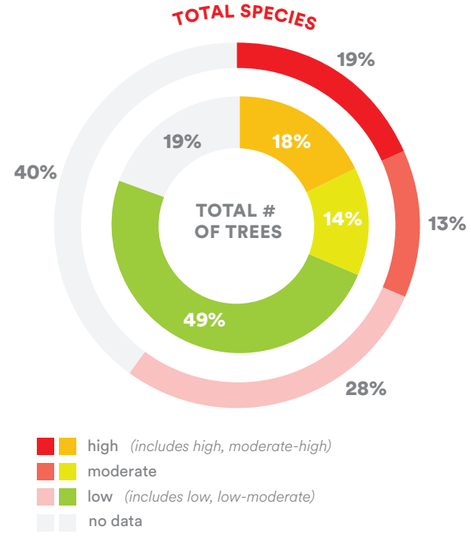
Trees that are considered moderately tolerant of high carbon emissions are those represented by the "Moderate" category. Nine species are moderately tolerant of high carbon emissions and represent approximately 14% of BPC's trees, or 245 trees. Trees that are considered intolerant of high emissions are those represented by the "Moderate-High" category (11 species or approximately 17%, or 304 trees) to "High" vulnerability categories (2 species or less than 1% or 10 trees). With these two categories combined, there are 13 species, representing 18% of BPC's trees, or 314 trees, that are intolerant of high carbon emissions.

Of those where data was available nearly 50% of the trees were already tolerant of high emissions, and approximately 14% were moderately tolerant of high carbon emissions. Understanding the 13 tree species or 18% of BPC's trees that are intolerant of high carbon emissions may assist BPCA in making plant selection decisions for the future. **BPCA may want to consider these species for total phase out or selected only for limited use in future planting palettes and replaced with those tree species expected to tolerate moderate to high emissions.**

As described above, 40% or 28 species of trees (342 trees) did not have adaptability scores. As additional climate vulnerability research is conducted, additional species would be expected to be evaluated, and added to the list(s). As data become available, BPCA may consider updating its dataset and analyses overtime to better understand BPC's UTC with respect to high carbon emissions.



*The Callery pear (Pyrus calleryana) has a climate change vulnerability score of Moderate-High.*




*The breakdown of climate vulnerability within BPC's urban tree canopy (under a high emissions scenario).*



*Kentucky coffeetree (Gymnocladus dioicus) is a useful native street tree with a Low vulnerability score.*




*The climate vulnerability of BPC's canopy trees under a high emissions scenario.*

# CANOPY COMPOSITION

Diversity is an important element of a healthy, resilient urban forest. Battery Park City's tree composition was analyzed with respect to age class distribution and diversity in terms of species, genus, and plant family.

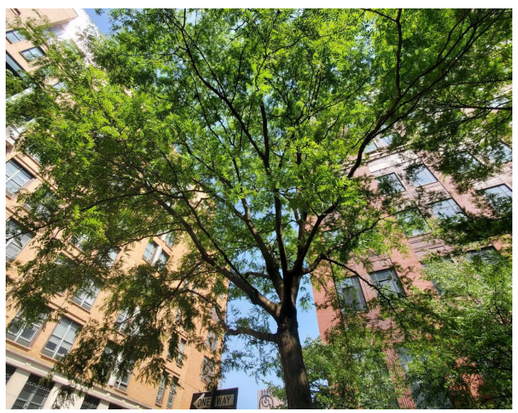
Age class distribution is the analysis of the makeup of a forest with respect to tree size (size correlates with age). The main size metric used for age class distribution is trunk diameter. A diversity of age classes is a characteristic of a healthy urban forest and can support resilience to large-scale disturbances. BPC's tree canopy was compared to the idealized 40-30-25-5 age class distribution metric commonly used and recommended by arborists where 40% of the canopy is comprised of the youngest trees under 5.9" diameter, 30% are between 5.9" and 23.6" diameter, 25% are 23.6" to 35.4" and only 5% are over 35.4" in diameter.

When examining the age class distribution of the trees inventoried, the younger trees in the 0- to 5.9-inch diameter category fell short of the 40% goal by more than 20%, the 5.9- to 23.6-inch diameter category exceeded the 30% goal by up to 50%, older trees in the 23.6-inch to 35.4-inch diameter size class fell far short of the 25% goal, and there were no trees over 35.4-inch diameter. Almost 80% of trees fell within the 5.9" to 23.6" diameter age class.

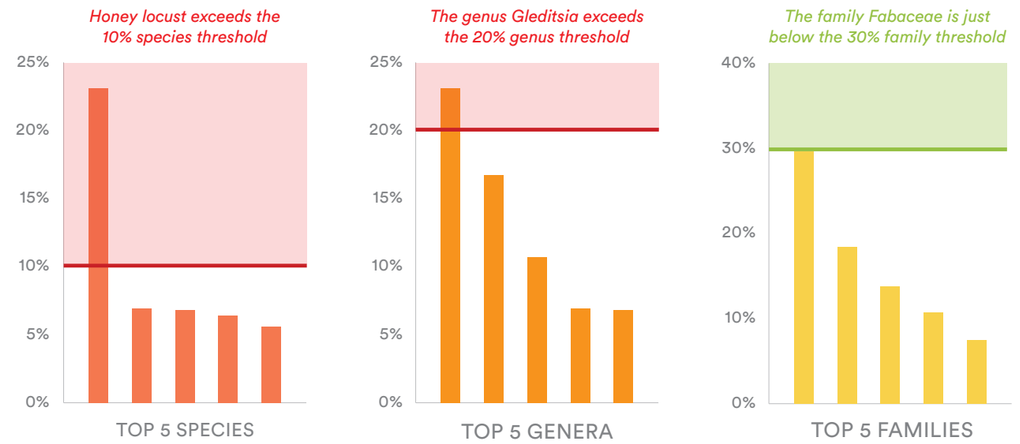
Diversity among species, genus, and plant family provides resilience within an urban forest by reducing risks associated with pests, disease, and climate change. A lack of diversity in canopy composition can leave an urban forest vulnerable to wide-spread tree loss due to a single agent such as an insect, pathogen, or other pests that have the potential to adversely impact or decimate a single tree species. Biodiversity in canopy composition was measured with respect to the 10-20-30 metric for tree diversity, which serves as a framework used by arborists for the ideal species, genus, and family composition for promoting future urban forest longevity. The 10-20-30 metric provides a guideline that an urban tree population should include no more than 10% of any one species, 20% of any one genus, and 30% of any one plant family.

For BPC's trees, the most dominant species, honeylocust (*Gleditsia triacanthos*), represented approximately 23% of the tree population exceeding the goal by slightly more than 13%. The most dominant genus, *Gleditsia*, also represented approximately 23% of BPC's trees, which exceeds the goal by only 3%. Just under 30% of BPC's trees consisted of trees within the Fabaceae family, which includes honeylocusts, eastern redbud (*Cercis canadensis*), American yellowwood (*Cladrastis kentukea*), Japanese pagoda tree (*Styphnolobium japonicum*), and Kentucky coffeetree (*Gymnocladus dioicus*). The 30% family goal is very nearly met, due in part to the fact that there were only four other tree species within the same family.

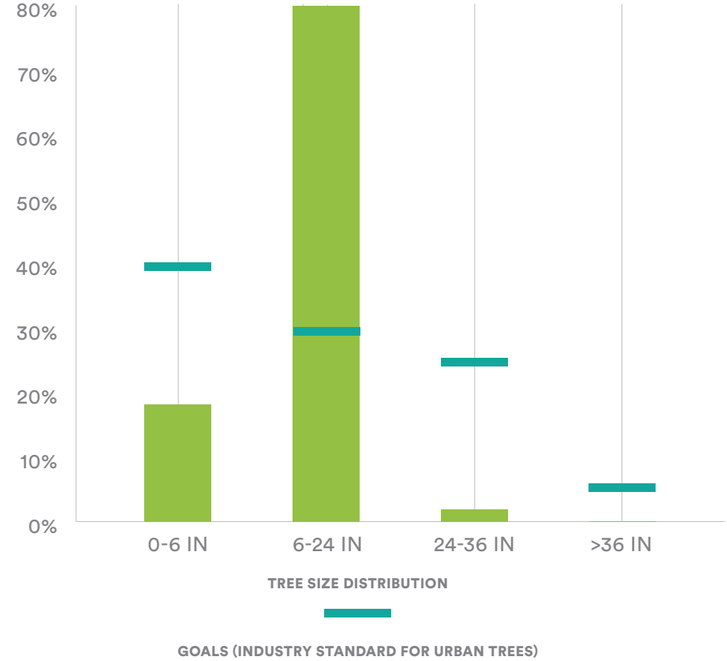
**Canopy composition can be improved through new plantings with consideration placed on species selection for increased diversity and by finding new opportunities in site selection to increase the percentage of younger trees within BPC's tree canopy.**



*Honey locust trees (Gleditsia triacanthos) make up almost a quarter of all trees in Battery Park City.*




*The proportion of the top five tree species, genera, and families in Battery Park City in relation to their target abundance following the 10-20-30 rule.*




*The age class distribution of all trees in Battery Park City.*

# OUTDOOR THERMAL COMFORT

An outdoor thermal comfort study of Battery Park City was completed as part of this work. The study aimed to comprehensively analyze the area's microclimate and its impact on occupants' outdoor comfort. In the citywide context, BPC is in fact a shelter from rising temperatures due to the rich urban tree canopy and green open space the neighborhood provides. Across NYC, areas with significant vegetated space are cooler and more comfortable on average, establishing a clear connection between urban tree canopies and urban heat island mitigation.

With this in mind, the study investigated the local microclimate of Battery Park City to identify areas that might be less comfortable than other spaces and for what reasons. This outdoor thermal comfort study produced a robust baseline model and set of maps of thermal comfort across all outdoor areas of the study area. The resulting maps detail how factors like air temperature, solar exposure, wind, and existing shade from the nearby urban context and tree canopy, influence people's experience in an outdoor space. Findings illustrate how comfortable areas of Battery Park City are in relationship to the Universal Thermal Climate Index (UTCI). The UTCI is an equivalent temperature scale for quantifying the level of thermal comfort a person experiences. It also categorizes results into different comfort groups, ranging from extreme cold stress to extreme heat stress. With the results from the study, sets of maps were created to illustrate the percentage of annual hours that are comfortable in Battery Park City. UTCI combines factors including air temperature, relative humidity, wind speed, and radiant temperature (the effects of surrounding surface temperatures).

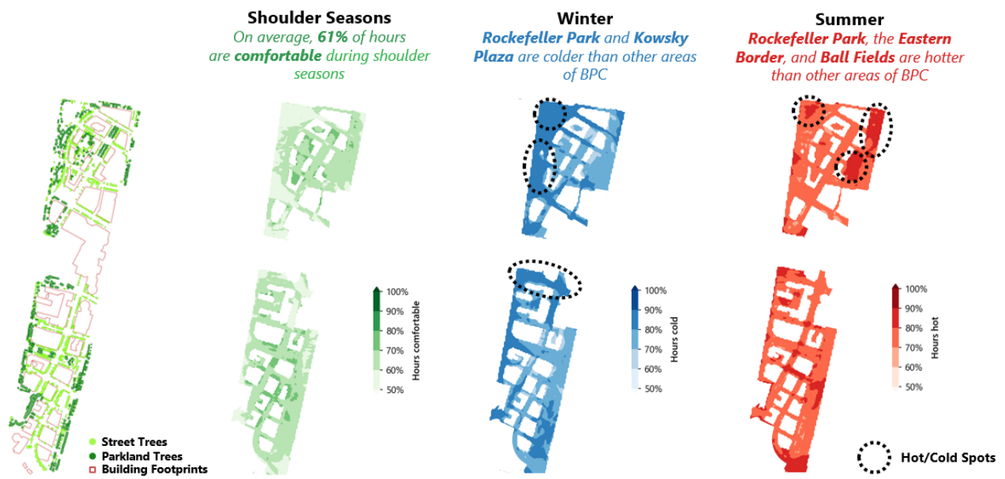
Approximately 60% of the hours during a focus period of typically occupied outdoor space from 8am to 6pm each day, experience no thermal stress during the shoulder seasons of Spring and Fall. During the focus period, areas surrounding buildings are subject to higher wind where people would feel moderate cold stress for about 24% of time. However, shelter from wind also causes some localized areas to experience moderate heat stress for 15% of the hours.

For the Summer months, heat stress is moderate. On average, about 78% of the hours within the focus period experience at least moderate heat stress. Heat stress is prevalent during the summer months due to the high air temperatures, solar intensity, and sunlight hours. Direct solar exposure is most effective in creating heat stress environments. During the Summer months, Rockefeller Park stands out along with the Eastern Border and the Ball Fields. These areas tend to be hotter due to the lack of tree canopy coverage and shade. Therefore, shading elements in localized areas can typically help with mitigation of heat stress.

For the Winter months, cold stress is predominately moderate to strong. Approximately 79% of the time during this period, users will experience some form of cold stress. Cold stress is prevalent during winter months due to lower temperatures, shortened sunlight hours, and strong winds. Wind is especially effective at reducing comfort as the air feels much lower, and regions of discomfort mostly exist where winds are >9mph along the shoreline and where there are structures creating wind tunnels. However, wind shelters, such as buildings, can be effective in preventing strong cold stress. Rockefeller Park and Kowsky Plaza are two areas that are colder than typical BPC open areas, likely due to winter winds and a lack of shelter from trees or buildings.

As part of the study, the team evaluated four potential mitigation strategies: shade, wind shelter, mist, and thermal mass. For each strategy, the UTCI model was adjusted to reflect the impact of the intervention. Shade was modeled by including a canopy shade over the individual; wind shelter by having four walls blocking wind only around the person; mist by increasing humidity and reducing air temperature; and thermal mass by replacing the ground material with higher thermal absorbance. Without any intervention, the annual average outdoor comfort percentage of a person in an open field in NYC is 34%.

The comfort level for each strategy is shown below along with the open field baseline condition. The graph indicates the best mitigation strategies are providing shade for mitigating heat stress and deploying wind shelter for cold stress. To maximize the seasonal benefits, we created a combined strategy providing overhead shade during the period of April 10th to November 10th and replacing it with wind shelter for the rest of the year. This combined approach increased the ideal comfort condition in an average year to 57% of the hours of the focus period. This set of interventions can be mixed and matched across BPC to alleviate some of the heat and cold stress in target areas. As interventions are further studied, additional UTCI analysis can model and illustrate the improvement in comfort conditions across BPC assuming implementation of interventions.




*Results summary of Battery Park City Outdoor Thermal Comfort Study by season.*

| Stress Category | Baseline – Weather Condition | Shade Intervention | Wind Shelter | Evaporative Cooling / Misting | Thermal Mass | Combined Wind Shelter and Shade |
|---|---|---|---|---|---|---|
| Extreme heat/cold | 0% | 0% | 0% | 0% | 0% | 0% |
| Very strong heat/cold | 5% | 0% | 7% | 4% | 5% | 0% |
| Strong heat/cold | 15% | 5% | 14% | 14% | 15% | 3% |
| Moderate/ slight heat/cold | 45% | 48% | 40% | 47% | 45% | 40% |
| No thermal stress | 34% | 46% | 39% | 35% | 34% | 57% |

*Potential interventions and implications on thermal comfort.*

# Management

The maintenance section of BPC's Urban Tree Canopy Assessment examined individual tree conditions and provided recommendations on future maintenance. It evaluated the overall tree condition, and specific maintenance recommendations, including pruning, soil amendments, and plant healthcare recommendations.

A total of 1,759 live trees, 6 dead trees, and 8 stumps were recorded during the tree inventory. Of the 1,759 live trees, approximately 98% of the total were identified as being in "Excellent" or "Good" condition.

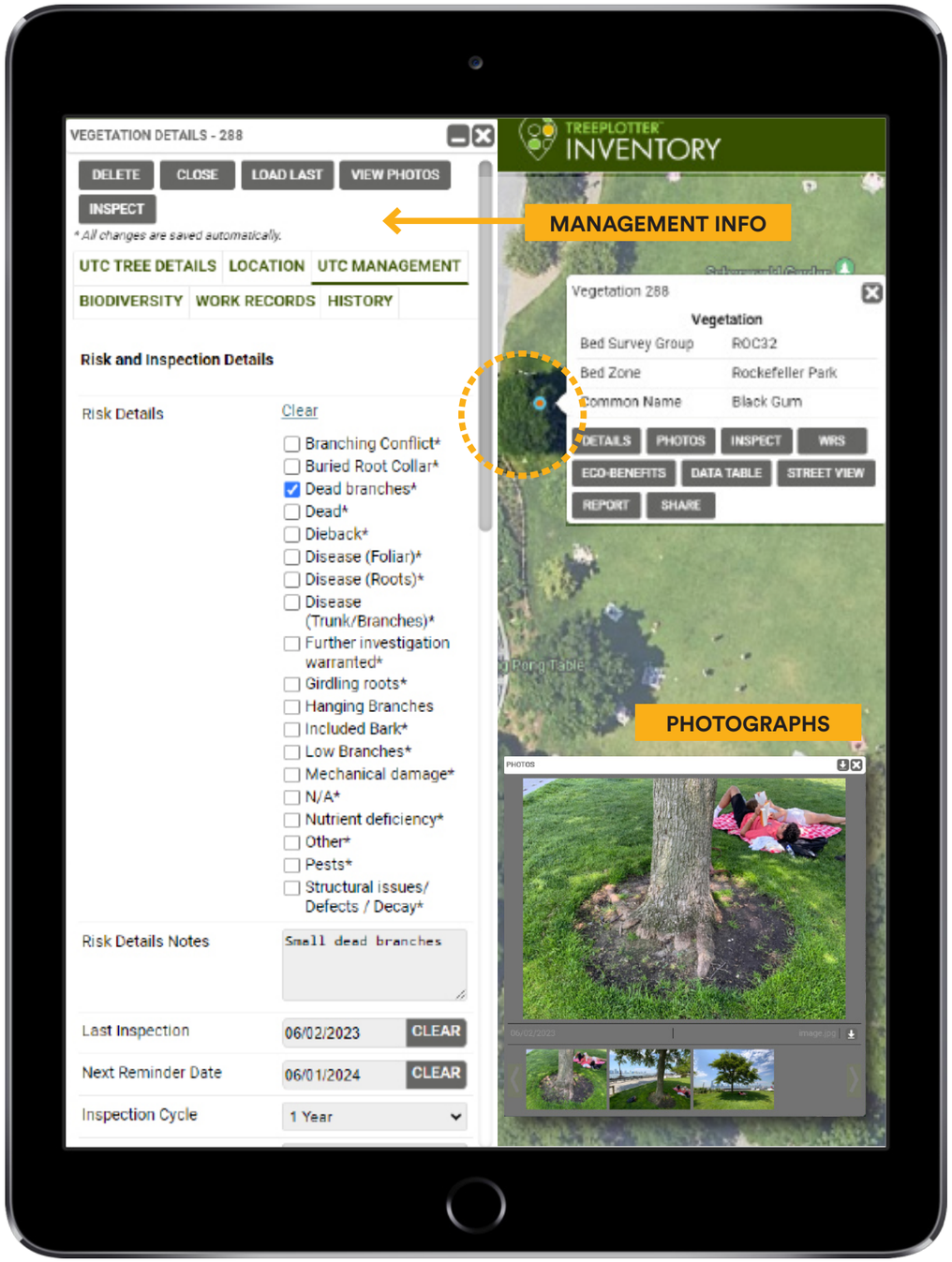
With respect to pruning, a total of 437 trees, or approximately 25%, were identified as requiring pruning within the next 6 months. Recommendations regarding pruning focused on mitigating hazards, and structurally training trees for optimal form within the landscape. These recommendations include the pruning of deadwood, which can be performed at any time of the year, and the recommendation to prune live tissue in March and April to ensure optimal wound closure and protection from disease.

A total of 178 trees or approximately 10% were identified as requiring soil amendments within the next 6 months. Soil amendment recommendations considered the soil makeup and whether tree foliage exhibited signs of deficiencies, such as chlorotic leaves. Soil amendment recommendations included the continued use of BPCA's compost tea, as well as the application of 2 to 4 inches of mulch, while ensuring that the tree root collar is exposed. In addition, it was recommended that BPCA perform a soil analysis on trees identified as having chlorotic leaves or other nutrient deficiencies. If the laboratory identifies that the soils associated with these trees relate to organic matter deficiencies, macro- and micro- nutrient deficiencies and/or soil-pH, then it is recommended that a prescription fertilizer be tailored specific to the soil analysis.

A total of 446 trees, or approximately 25%, were identified as requiring general plant healthcare maintenance (i.e., pest and disease treatments, root collar excavation, girdling roots remediation) within the next 6 months. As part of this process, it is recommended that BPCA remove any girdling roots under 2" in diameter. If girdling roots are larger than 2" in diameter, it is recommended that BPCA's forestry staff and/or a Certified Arborist evaluate the tree(s) and determine if the removal of the girdling root can be performed without compromising the health of the tree(s). For trees recommended for root collar excavations, it is recommended that any excavations be performed using an air spade to prevent incidental mechanical damage. Following root collar excavation, it is recommended that tree pit soils be treated with biochar and a 2-to-4-inch layer of mulch. For trees recommended for foliar application and systemic pesticide drenches, it is recommended that trees be inspected by BPCA forestry staff/Certified Arborist prior to the 2024 growing season, and an integrated pest management (IPM) plan be tailored to meet the demands of BPCA, including the use of Organic Materials Review Institute (OMRI) and National Organic Program (NOP) compliant products.



*BPC staff install a trap for spotted lanternfly to combat infestation.*




*The TreePlotter interface, showing management information inputs and pictures of previous management activities.*

# Conclusion

BPCA has made significant progress in meeting the goals of its Sustainability Plan Site Strategies “Biodiversity and Habitat” and “Quality of Life” goals through the work of this project. This executive summary above represents a small portion of the data, analysis, findings, and recommendations provided in the 2023 Urban Tree Canopy Assessment and Recommendations and the 2023 Biodiversity Data Audit and Recommendations reports. Overall, Battery Park City Authority is on track to meet many of its goals as described in this document.

This project has provided BPCA with an assessment of existing BPCA procedures, a precedent study of other entities’ biodiversity programs, a baseline inventory of BPC plant species, a tool (TreePlotter) to document, monitor, and organize landscape management observations and tasks, and a set of standard protocols to conduct plant species inventory future surveys.  The full reports of this project include results from data analysis performed on the baseline tree and plant species inventory across several subject areas: overall biodiversity including general biodiversity, native species and invasive species; resiliency including drought, saturation, salt spray, saltwater inundation, and salty soils tolerance; and habitat and wildlife support including specialist insects, birds, bloom period, and wildlife; as well as climate vulnerability, canopy composition, urban heat island, and maintenance. This analysis was performed for BPC for all areas surveyed, as well as analyzed by park. In some cases, analysis for selected survey groups was shown to illustrate a specific analysis finding and illustrate how more detailed analysis could be performed with the data provided.

The results provide an informed baseline for BPCA that can guide management and strategic planning. The recommendations provided are actionable and include two key categories: study and analysis recommendations and design and management recommendations. All of which are intended to guide BPCA in further advancing their goal to “target higher biodiversity, which would improve their resilience to different climatic conditions, improve their ecological health, and provide and support broader ecosystem services.”

## RECOMMENDATIONS FOR FURTHER STUDY AND ANALYSIS

| | |
|---|---|
| **BIODIVERSITY** | Use the data collected to calculate one or more plant species biodiversity indices for BPC. |
| | Build partnerships with adjacent open space organizations such as the Hudson River Park Trust and the Battery Park Conservancy to compare metrics and better understand trends in plant biodiversity across jurisdictions. |
| | Review the NYC Tree Map dataset and compile data for species that are not currently present in BPC for potential future use in plantings. |
| **HABITAT & WILDLIFE** | Update wildlife value scores for plants in the database as additional data becomes available |
| | Perform dedicated surveys of birds and specialists insects in areas calculated to have high habitat value for those species.. |
| | Overlay plant and wildlife observation points to better understand symbiotic relationships through-out the park. |
| | Increase wildlife documentation: Continue to engage the public in BioBlitzes and general species inventories. |
| | Increase wildlife documentation: Partner with trained ecologists to perform dedicated inventories on less observed groups, such as specialist bees, nocturnal moths, aquatic species, or fungi. |
| **RESILIENCY** | Update plant species characteristics database with new data as they become available. |
| | Compare BPC age distribution / diversity composition to other parks of similar age. |

## RECOMMENDATIONS FOR PLANNING, DESIGN, AND MANAGEMENT

| | | |
|---|---|---|
| **BIODIVERSITY** | Enhance General Biodiversity | Add new species to beds with low species counts or low species/unit area for more diverse planting. |
| | | Offset the honey locust population by planting new trees/replacement trees with other species where possible. |
| | Increase Native Species | Expand native plantings throughout the park, especially in areas below 50% coverage. |
| | | Identify the planted areas with the highest native coverage and use as models for other areas. |
| | | Reduce the coverage of overabundant non-native species such lilyturf or periwinkle. |
| | Manage Invasives | Create an invasive species management plan. |
| | | Commit to not plant more invasive species. |
| | | Monitor garden beds for invasive tree saplings. |
| | | As invasive trees require removal (e.g., construction, damage, decline) replace with non-invasive species. |
| **HABITAT & WILDLIFE VALUE** | Enhance Bird Habitat | Enhance the structural complexity of planting beds to provide a wider variety of habitat niches. |
| | | Consider understory and overstory diversity when planting new trees. |
| | | Designate open areas for meadow and grassland plantings to support species such as goldfinches and hawks. |
| | Enhance Insects | Identify gaps in habitat connectivity larger than 150m and target for planting with specialist-supportive species. |
| | | Plant keystone native trees/shrubs such as Quercus, Prunus, and Salix as well as keystone perennials like Helianthus and Solidago. |
| | | Where design intentions deviate from native plantings, plant non-natives with documented support for native specialist insects. |
| | Expand Bloom Periods | Increase coverage of October-blooming species to offer late-season support for pollinators. |
| | | Commit to 10% vegetative coverage of blooming native species from April-October. |



## RECOMMENDATIONS FOR PLANNING, DESIGN, AND MANAGEMENT

| | | |
|---|---|---|
| **RESILIENCY** | Improve Drought Tolerance | Identify areas of high-medium drought concern/exposure and create a plan to: Align planting palettes and Calibrate irrigation systems with locations of risk and periods of drought. |
| | | Use the Resiliency Matrix developed for future tree selection. |
| | | Use drought-tolerant trees in locations without irrigation. |
| | | Use water bag irrigation in times of drought for drought-intolerant trees. |
| | Improve saturation tolerance in exposed areas | Identify areas of poor drainage and overlay with saturation data to understand potential risks. |
| | | Use TreePlotter to document and monitor signs of stress to better align planting palette in poorly drained areas. |
| | | Monitor and adjust irrigation during wet weather periods. |
| | | Use Resiliency Matrix for tree selection. |
| | | Update database as data become available. |
| | Improve salinity tolerance in exposed areas | Increase coverage of salt-tolerant planting in exposed areas: waterfront parks, streetscape, and the Eastern Border. |
| | | Phase out plant/tree species with known non-tolerance in exposed areas. |
| | | Refer to Resiliency Matrix for tree selection. |
| | | Update database as data become available. |
| | Improve Age Class Distribution (tree specific) | Replace dead trees/stumps. |
| | | Evaluate trees in fair/poor condition. |
| | | Evaluate planting options (e.g., lawns/edges). |
| | | Use 40-30-25-5 metric during planning. |
| | Increase tree canopy diversity (tree specific) | Replace honeylocusts with other species as opportunities arise to strengthen resilience to pests, disease. |
| | | Use the 10-20-30 metric during planning. |
| | Reduce climate vulnerability of tree species | Update database as data become available for the remaining 40% of trees with no data |
| | | Consider phasing out or limiting the ~20% trees/species that are intolerant of high emissions. |
| | | Reference Resiliency Matrix when planning for new tree plantings. |


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